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[SUPPLEMENT TO "ENGINEERING," JANUARY 19, 1872.]

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ENGINEERING:

An Illustrated Weekly Journal.

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ENGINEERING.

BAUSCHINGER'S INDICATOR EXPERIMENTS ON LOCOMOTIVES.

ONE of our aims in conducting this journal has always been to keep the professional community of this country conversant with the researches of the engineering philosopher abroad, and it is for this reason that we are glad to be able to lay before our readers a record of the exhaustive indicator experiments instituted by Professor Bauschinger, of Munich, with the assistance of M. Zorn, locomotive superintendent of Augsburg, on locomotives of the Bavarian state railways. These experiments were principally conducted with the view of examining, on the one hand, the distribution of steam effected by valve motions of various classes, and, on the other hand, of ascertaining the absolute work done by the steam in comparison with the simultaneous consumption of fuel and water. We shall follow, in our notice, the course of Professor Bauschinger's work on the subject,* which is divided into four principal sections, viz., 1. On the mode of conducting the experiments and on the tested engines in general; 2. On the form of the indicator curves; 3. On the absolute performance of steam and fuel; 4. On water and steam consumption.

1. *On the mode of conducting the Experiments and on the Tested Engines in General.*

The indicator employed by the experimenters was one of Richards's, supplied by Messrs. Elliott, of London, and was of the usual dimensions. The indicator was fixed on a three-way cock over the middle of a cylinder, as shown in the annexed Fig. 1, communicating with both cylinder ends by means of $\frac{3}{8}$ in. copper pipes. The instrument was handled, from the engineman's footplate, by two rods acting upon the indicator cock, *a*, and the three-way cock, *b*, while the barrel of the instrument, *c*, was connected with the piston rod crosshead in the manner illustrated. The crosshead moved, moreover, one of Schäffer and Budenberg's stroke-counters, placed in close proximity to the experimenter, who was standing, as before stated, on the engineman's footplate. After a diagram had been drawn the connexion between the indicator barrel and piston rod crosshead could be loosened, and an arrangement was also provided for enabling several curves to be taken, on one and the same paper, without mounting a new sheet on the barrel. As a rule a new diagram was registered for each change in the position of either the regulator, the reversing lever, the expansion hand (in the case of Meyer's valve motion), or the blast-pipe orifice. We readily admit that the method of taking the diagrams from the footplate permits of a more uniform system of observation, nevertheless we should ourselves give the preference to the plan in which the operator places himself beside the indicator; and we prefer this latter way of proceeding, on account of its enabling a far greater number of diagrams to be taken within a given time, than the other method, and also on account of its not depending so much on the working of gear, which, at any time, may go wrong.

In the trials under notice the speed of the engine was measured and registered by means of a chronometer, the period during which the regulator and the reversing lever remained unchanged was also carefully noted down, and in order to arrive at the corresponding number of revolutions of the drivers at the same intervals, from minute to minute, the state of the stroke counter was registered, as was also the boiler pressure. The feed water was measured by a glass gauge fixed on the tender, and the fuel was weighed. We are glad to be told by Professor Bauschinger—and this enhances greatly the practical value of the trials—that the engines were experimented upon in their normal condition, and while doing their ordinary work. It too frequently happens that in trials of this kind the duties of the engineman are interfered with or rendered perplexed by contrary orders, but we are told that this was not the case, and that the drivers were merely ordered to aim at maintaining the proper water level and boiler pressure.

FIG. 1.

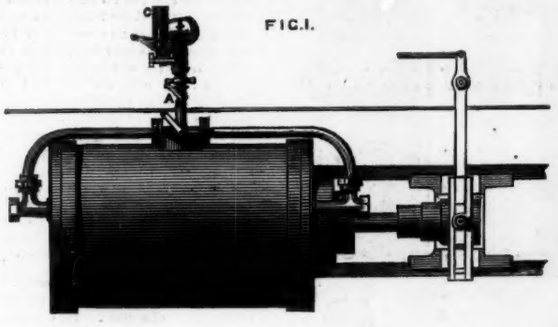


TABLE No. I.

Class of Engine.	Wheels. Number. Total.	Wheels. Number. Driving wheels.	Wheels. Diameter. Driving wheels.	Wheels. Diameter. Carrying wheels.	Weight of engines with water.	Diameter of cylinders.	Area of pistons in square inches.	Stroke of pistons.	Volume of one cylinder in cubic feet.	Length of connecting rod.	Firebox. Grate surface in square feet.	Firebox. Heating surface in square feet.	Boiler. Length.	Boiler. Diameter.	Boiler tubes. Number.	Boiler tubes. Length.	Boiler tubes. Inside diameter.	Boiler tubes. Heating surface.	Total heating surface.	Ratio of firebox surface to tube surface.	System of valve motion.	Tender. Wheels. Number.	Tender. Wheels. Diameter.	Tender. Contents in cubic feet.	Tender. Weight with water.
			ft. in.	ft. in.	tons	in.		in.		ft. in.			ft. in.	ft. in.		ft. in.	in.						ft. in.		tons
A	6	4	5 2	3 8	29.5	16	201	24	2.8	5 0	13	80	11 9	4 1	156	12 4	$1\frac{3}{4}$	945	1025	$\frac{1}{11.8}$	Stephenson.	6	3 0	300	20
B	Same as engine (A) except throw of eccentrics and lead.																								
C	6	2	5 0	3 0	20	13	131.5	22	1.7	5 7	9	49	12 2	4 0	126	12 8	$1\frac{1}{2}$	632	681	$\frac{1}{13}$	,,	4	3 0	200	14
D	6	6	4 0		34	18	254.4	26	3.8	8 11	16	88	12 10	4 1	178	13 4	$1\frac{3}{4}$	1089	1079	$\frac{1}{15}$	,,	6	3 0	370	20
E	6	2	5 6	3 8	22	15	176.7	22	3.2	5 6	11	52	9 8	4 0	158	10 1	$1\frac{3}{4}$	680	732	$\frac{1}{12}$	Meyer.	4	3 0	215	15
F	6	2	5 0	3 0	16	$12\frac{1}{2}$	117.8	20	1.8	5 0	9.5	54	8 8	3 4	109	9 2	$1\frac{3}{4}$	451	504	$\frac{1}{8}$	,,	4	3 0	115	10
G	6	4	4 9	3 0	30	16	201	24	2.8	5 0	13.5	73	12 0	4 4	142	12 6	$1\frac{3}{4}$	813	885	$\frac{1}{11}$	,,	6	3 0	210	15
H	6	4	4 5	3 0	26	15	176.7	24	2.4	5 0	11.3	65	12 0	3 7	114	12 6	$1\frac{3}{4}$	650	715	$\frac{1}{10}$	,,	6	3 0	210	15

TABLE No. II.

Class of Engine.	Pre-admission. In millimetres. hind	Pre-admission. In millimetres. front	Pre-admission. In per cent. of piston area. hind	Pre-admission. In per cent. of piston area. front	Pre-admission. In parts of stroke. hind	Pre-admission. In parts of stroke. front	Compression in parts of stroke. hind	Compression in parts of stroke. front	Release. In millimetres. hind	Release. In millimetres. front	Release. In per cent. of piston area. hind	Release. In per cent. of piston area. front	Release. In parts of stroke. hind	Release. In parts of stroke. front
E	3	0	1.1	0	$\frac{1}{100}$	$\frac{1}{00}$	$\frac{1}{17}$	$\frac{1}{36}$	0.6	3.1	0.3	1.4	$\frac{1}{170}$	$\frac{1}{360}$
F	0	3	0	1.1	$\frac{1}{00}$	$\frac{1}{117}$	$\frac{1}{103}$	$\frac{1}{36}$	5.6	2.7	2.3	1.1	$\frac{1}{30}$	$\frac{1}{171}$
G	1.5	1.5	0.6	0.6	$\frac{1}{1055}$	$\frac{1}{890}$	$\frac{1}{88}$	$\frac{1}{138}$	2.6	5.3	1.0	2.0	$\frac{1}{115}$	$\frac{1}{59}$
H 3 notch	3.7	3.7	1.4	1.4	$\frac{1}{147}$	$\frac{1}{147}$	$\frac{1}{25}$	$\frac{1}{14}$	6.3	6.3	2.3	2.3	$\frac{1}{26}$	$\frac{1}{70}$
H 2 ,,	4.6	4.6	1.8	1.8	$\frac{1}{78}$	$\frac{1}{71}$	$\frac{1}{19}$	$\frac{1}{9}$	7	7	2.6	2.6	$\frac{1}{19}$	$\frac{1}{39}$
H 1 ,,	5.2	5.2	2.0	2.0	$\frac{1}{53}$	$\frac{1}{53}$	$\frac{1}{9}$	$\frac{1}{4.6}$	7.5	7.5	2.8	2.8	$\frac{1}{71}$	$\frac{1}{19}$

* Indicator Versuche an Locomotiven, angestellt unter Mitwirkung des königl. Maschimenmeisters Zorn in Augsburg und bearbeited von Joh. Bauschinger, Königl. Professor am Realgymnasium in München.

The valve gear of the engines running on the Bavarian state railways is partly of the shifting link, or Stephenson class, and partly on a system of double-valve motion, known on the Continent as Meyer's motion. Of each category four engines were selected for trial, and of these engines we give the leading dimensions in the Table No. I. on the preceding page. They were all with outside cylinders, three being express, two goods, and the rest mixed engines. Two of the engines were fitted with Allen's or Trick's double admission valve, and it will be seen in the course of our epitome of the professor's investigations, that this valve shows very good results in connexion with the shifting link motion. In the case of Meyer's motion, the main or distribution valves are moved by the reversing links; but these are not used for expansion purposes, the reversing lever being either put full forward or fully thrown back. The eccentrics of the expansion valves are set at an angle of lead of 180°. Before we proceed to examine the indicator curves obtained by Professor Bauschinger we give, in Table No. II. on the preceding page, some figures taken from a diagram relating to the action of the main valves of the four engines with Meyer's valve gear.

FIG.2.

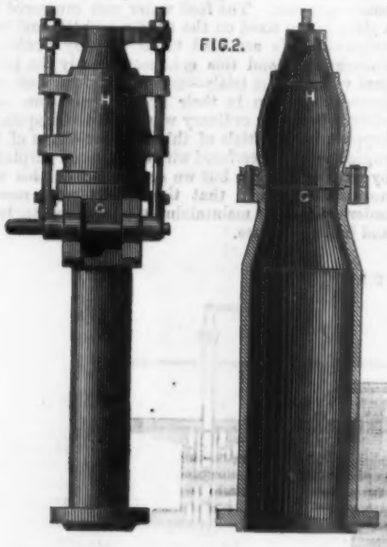
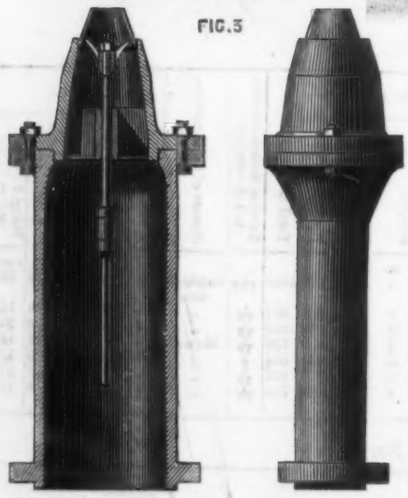


FIG.3



It will be noticed by examining this Table, that in the case of the fourth engine (H) the Table contains the values corresponding to *three* positions of the reversing lever; this being the only cases in which the distribution valves were also used for the purpose of expansion. In concluding our notes on the engines tested, we should state that, with the exception of engine (H), all were supplied with variable exhaust gear, worked from the engineman's footplate, and by means of which the blast-pipe orifice could gradually be contracted. The annexed Figs. 2 and 3, illustrate the two different arrangements adopted.

(*To be continued.*)

THE LOUISVILLE BRIDGE, U.S.A.*

THE bridge, illustrated this week by a two-page engraving, is of national importance, forming as it does the only connecting link of the great northern and southern railroad systems of America; as an engineering structure, it is also of general interest being the longest iron bridge in the United States, and comprising the longest trussed spans yet constructed in America. It connects directly the Louisville and Nashville Railroad, on the south, with the Jeffersonville, Madison, and Indianapolis Railroad on the north side of the river, and was built by the Louisville Bridge Company, in which these roads are large stockholders.

Arrangement of Spans.

The bridge proper is 5294 ft. long, divided into spans of the following lengths (from centre to centre of piers) commencing at the Kentucky end.

		ft.
Kentucky abutment	... ...	32.5
2 spans of 50 ft.	... ...	100.0
1 pivot draw over canal	of 264 ft. ...	264.0
	ft.	
4 spans of	149.6	598.4
2 ,,	180.	360.0
2 ,,	210.	420.0
2 ,,	227.	454.0
1 ,,	370.	370.0
6 ,,	245.5	1473.0
1 ,,	400.	400.0
3 ,,	180.	540.0
1 ,,	149.6	149.6
1 ,,	100.	100.0
Indiana abutment	32.5 ft.	32.5
		5294.0

Grade.

The grade of track approaching the bridge on the Kentucky side coincides with that of the street nearest the end of bridge at its crossing; from this point it ascends at the rate of 76 ft. per mile, striking the first span of bridge at an elevation of 63 ft. above low water, and continuing till the 370 ft. span is reached at a distance of 2500 ft. from the street and 2229 ft. from back of abutment; here the track has an elevation of 95 ft. above low water, from this point the grade is level for 2243 ft. to the north end of the 400 ft. span where it has an elevation of 101½ ft. above low water (low-water mark here being 6½ ft. below that at the 370 ft. span); from the 400 ft. span the grade descends at the rate of 76 ft. per mile for 700 ft. to the Indiana abutment, where it has an elevation above the natural surface of the ground of 35 ft.; from this point it descends on an embankment at the same rate till it reaches the ground at a distance of 2500 ft. from the abutment.

Foundations.

The river piers rest directly on the solid rock bed, and the shore piers and abutments on hard clay. These foundations, with the exception of a few in the most rapid water, were secured with but little difficulty.

Masonry.

This is of limestone laid in cement, and is of the most substantial character. It consists of 26 piers and two abutments varying in height from 40 ft. to 100 ft., and comprises in the aggregate 30,000 cubic yards. The piers on the grades are 6 ft. × 21 ft., those between the channels 7 ft. × 21 ft., and those on which the long spans rest 10 ft. 5 in. × 33 ft. 5 in. (rectangular) under the copings, all having a batter of 43 in. per foot.

Superstructure.

With the exception of the channel spans, all of the superstructure is placed below grade. The below grade or deck portion (excepting the canal draw which is entirely of wrought iron on the triangular plan) is on the plan of Fink's suspension truss; in this the chords, post shoes, cross struts, and floor beams (arched with tie rods) are of cast iron, the posts wrought, Phœnix columns, and the tension members of the best wrought iron. The weight is supported by two trusses placed 16 ft. apart between centres; these trusses rest at the piers on planed surfaces on which they are free to move when affected by changes of temperature. The channel spans are 370 ft. and 400 ft. in length from centre to centre of piers, and are a modification of the triangular plan. This modification consists in the introduction of secondary or auxiliary trusses, which render it possible to use an economical length of panel in the primary triangular truss, and by fixing the braces at their middle, effect a great saving of material.

The weight is supported by four trusses, two on each side of roadway. Although the trusses on each side are securely connected by bolts and struts, forming in effect a single truss, this connexion was not made till each had been allowed to support its own weight, and assume its natural curve uninfluenced by any connexion with its neighbour; by this arrangement the possibility of undue strains from inaccuracy of workmanship is avoided.

It is of interest to note that when this swung independently, no perceptible difference could be observed in the curves of the four trusses, which were bolted together in pairs, without reaming or chipping. In these spans the chords, brace shoes, and cross struts are of cast iron, and the braces and posts of wrought iron. The roadway is supported on trussed wrought-iron floor beams, on which it rests in such a way as to be independent of any movement of the span. The pairs of trusses are placed in the 370 ft. span 25 ft. and in the 400 feet 25 ft. 7 in. apart between centres, and the trusses of each pair respectively 34 in. and 41 in.; the clear span for roadway being 20 ft. 6 in.

The depth of truss from centre to centre of chords is in each span 46 ft. These spans rest on rollers at both ends, on which the movement due to change of temperature takes place. The entire bridge is in addition to its own weight proportioned for a rolling load of 2600 lb. per lineal foot. The factor of safety in the cast-iron chords is from 6 to 7, and in the wrought iron braces and posts from 5 to 6 by Hodgkinson's formulæ.

The strain on the wrought-iron tension members is varied according to their position and duty, in accordance to the principle adopted by Mr. Fink; for example, the suspension and small truss bars of the channel spans, which are subjected to a maximum load at the passage of each train, have a section corresponding to a strain of 7000 lb. per square inch, while their bottom chords and the main systems of the Fink suspension trusses, which rarely if ever are subjected to the maximum calculated strain, have a section corresponding to 12,000 lb., other members are proportioned for intermediate strains, 7000 lb. being the mimimum and 12,000 lb. the maximum.

The connexions throughout are by pins, which are subjected to a shearing strain of from 6000 to 7000 lb. per square inch. All of the wrought iron used for tension was tested with a strain of 20,000 lb. per square inch, its ultimate strength being 60,000 lb. and the cast iron was subjected to the most approved tests for quality and soundness.

The bridge as completed has a single track in the centre for railroad traffic, and foot-walks on each side 6 ft. wide, raised 11 in. above the rail bearing. A width of 14 ft. along the centre line of bridge appropriated to the use of trains, is not floored over. Each foot-walk is confined by two lines of railing, a low one separating it from the train way, and one 4 ft. high on the outside; with this arrangement there are four lines of railing the entire length of the bridge. These foot-walks and railings have been constructed since the taking of the photograph from which our engraving of the bridge was made, and besides affording a beautiful promenade, add much in appearance to the general finish of the structure.

In some future number of ENGINEERING we shall illustrate and describe in detail by drawings, the channel spans and some of the most important deck spans of this bridge. The masonry was commenced in August, 1867, by contract, but not being pushed satisfactorily, was, in the following year, taken charge of by the company, and finished under the direct management of the engineers, the last stone being laid November 24th, 1869.

The ironwork was finished by the Louisville Bridge and Iron Company, who delivered it at the bridge site ready for erection at a certain price per pound, the Louisville Bridge Company erecting the same at their own expense and risk. The erection of the superstructure was commenced in June, 1868, and completed for the passage of trains February 12, 1870, a delay of two months having been sustained on account of the washing out of the last span of false work on the 7th December, 1869. During more than a year's actual service it has sustained all the tests imposed by the heavy traffic incident to its position in a manner entirely satisfactory to all interested. This great work has been designed by and erected under the supervision of Messrs. Albert Fink, chief engineer, and F. W. Vaughan Prin, assistant engineer. Its total cost from abutment to abutment was $1,600,000.

* See ENGINEERING, vol. v., page 507.

MESSRS. RANSOMES, SIMS, HEAD, AND CO.—We are requested to state that Mr. John R. Jefferies, who has for the last fifteen years been engaged with the above named firm, and who is the son-in-law of its senior partner, has just become a member of the firm, the name of which, however, will not be altered.

SANITARY REFORM AT ROSARIO.—In consequence of the lamentable outbreak of yellow fever at Buenos Ayres, the inhabitants of Rosario have been discussing the best means of carrying out effective sanitary measures at that town. It is estimated that an outlay of 1,500,000 patacoons would place Rosario in possession of a proper water supply and a good system of drainage.

AUSTRALIAN TELEGRAPHY.—In the first quarter of this year the Queensland Government telegraphs earned 2620*l.*, but the working expenses were 4588*l.*, so that it would seem that the lines are carried on at rather a considerable loss. In Victoria, the Government has lately reduced the rates charged for the transmission of telegrams and the business has been doubled in consequence, the receipts having risen in March to 3147*l.* The number of messages received and transmitted in Victoria in January was 22,072.

SOUTH AMERICAN TELEGRAPHY.—A privilege for forty years has been granted to Messrs. Lamas for laying a submarine cable between Rio and Buenos Ayres. Buenos Ayres is now in electric communication with the remotest provinces of the Argentine Confederation; by the end of this year the Argentine Republic will probably be also enjoying telegraphic intercourse with Chili and the Pacific coast. The Banda Oriental Government has granted a concession of a line between Monte Video and Yaguakon in Rio Grande. The works of the Transandine telegraph have been commenced on the Chilian side of the Andes and are being pushed forward vigorously.

SIX-HORSE TRACTION ENGINE AT THE WOLVERHAMPTON SHOW.

CONSTRUCTED BY MESSRS. JOHN FOWLER AND CO., ENGINEERS, LEEDS.

(*For Description, see Page* 7.)

THE WOLVERHAMPTON SHOW.

IN our last week's article we gave an account of the doings of the Royal Agricultural Society, at Wolverhampton, up to the evening of the 29th ult., and we have now to lay before our readers particulars of the trials of agricultural locomotives and ploughing engines which have been carried on since that date, as well as to supply further details of trials of which we have hitherto only given the general outline. Since the appearance of our last number the trials of the agricultural locomotives have been completed, and it is of these trials which we intend in the first place to speak.

As we have already explained, the Royal Agricultural Society this year abandoned the restrictions as to boiler pressure and load on the brake, which have so long detracted from the value of their competitive trials, and they, moreover, made arrangements for obtaining indicator diagrams from each engine during its run, and for ascertaining the amount of water evaporated and lubricating material consumed. This being the case, the brake trials at Wolverhampton have afforded much really valuable information of a kind not hitherto generally available, and we feel certain that they will materially aid the progress of agricultural engine building. Thus the use of the indicator has revealed valve setting of a kind which scarcely would have made its appearance had the engine builders themselves employed this instrument as they ought to do, and in this respect we trust to see an improvement in future competitions. Again, the records of the quantities of water evaporated show the comparative values of the various boilers as steam producers, as distinct from the properties of the engines as steam users, and we are thus enabled to trace out the cause to which the success or non-success of any particular engine is due. To enable our readers to do this more readily we have, in Table No. II., on page 5, not merely recorded the coal and water used by each engine, but have also worked out the consumption of coal per square foot of fire-grate per hour, and the evaporation of water per square foot of heating surface per hour; while we have likewise introduced columns giving the amounts of work done per pound of coal and of water consumed, and others showing the effect of employing a portion of the exhaust steam for heating the feed-water.

Regarding the effect of this latter practice on the apparent and real evaporative efficiency of the boiler, it may be advisable that we should say a few words here. Arrangements for heating feed-water by a portion of the exhaust steam may be divided broadly into two classes, the first consisting of those heaters in which the condensed steam becomes mingled with the feed-water, and the second — and less common — variety, including those in which the water arising from condensation does not so mix with that entering the boiler. In the case of the competitive engines at Wolverhampton, all the feed-heaters belonged to the former class, and it is of that class only, therefore, that we have here to speak.

In all cases where the feed water is heated simply by leading into the tank a branch pipe from the exhaust, it may safely be assumed that the steam by the time it reaches the water is practically at atmospheric pressure, and the total heat of each pound of it thus amounts (calculating from the zero of the Fahrenheit scale) to 1178 pound-degrees. In condensing, each pound of the steam of course gives off to the cold feed this number of pound-degrees of heat, less the number representing the temperature of the feed water when heated. Thus if the temperature of the heated feed water be 170°, each pound of exhaust steam condensed will give up to it 1178 — 170 = 1008 pound-degrees of heat, and so on. This amount of heat would of course be sufficient to re-evaporate the condensed steam under atmospheric pressure; and if the boiler was worked at that pressure, its evaporative efficiency might be simply measured by the quantity of cold feed supplied to it, the additional water resulting from the condensation of a portion of the exhaust steam bringing with it an amount of heat sufficient for its re-evaporation. When a boiler is worked under pressure above that of the atmosphere, however, the case becomes different, as the total heat of the steam produced is then greater than that of the exhaust steam condensed, and the heating surface, in addition to supplying the heat necessary for the evaporation of the fresh or cold feed water, has also to furnish the amount of heat representing the difference between the total heat of the exhaust steam and that of the new steam produced. Under such circumstances, therefore, the real evaporative efficiency of the boiler will be higher than it would appear to be from a measurement of the feed water supplied; or, in other words, the boiler will really be doing more work than it would be if it was merely evaporating the same quantity of cold feed water, and the heating arrangement was not in use. The real economy of the feed heating arrangement consists in its reducing the quantity of water which has to be evaporated through the instrumentality of the boiler-heating surface.

The consideration of a particular instance may, perhaps, assist in explaining this matter more clearly, and we shall take, as our example, Messrs. Aveling

and Porter's 10-horse engine, which was *facile princeps* in the brake trials, and the performance of which is recorded in the first line of Table No. II. Referring to the Table, it will be seen that this engine had 3200 lb. of feed water supplied to it, that the temperature of the feed was 170°, and that the above-mentioned quantity of water was evaporated by the consumption of 420 lb. of coal. Calculated in the ordinary way, this would give an evaporation of $\frac{3200}{420} = 7.62$ lb. of water per pound of fuel; but in reality the boiler did more than this. To heat the feed water from the natural temperature of, say, 55° to 170° required $(170-55)\times 3200 = 368{,}000$ units of heat, and this must have been supplied by the condensation of $\frac{368{,}000}{1178-170} = \frac{368{,}000}{1008} = 365$ lb. of exhaust steam. The amount of feed water was thus increased to $3200+365 = 3565$ lb., and it was this quantity which the boiler had to evaporate from a temperature of 170°, or, in other words, the evaporation from that temperature amounted to $\frac{3565}{420} = 8.488$ lb. per pound of coal consumed. But the mean pressure at which Messrs. Aveling and Porter's boiler was worked was 115 lb. per square inch, and the total heat of steam of that pressure is 1219.3° or say 1219°, an amount 31° greater than that of the exhaust steam which is condensed, and we thus see that, in addition to evaporating the cold water supplied, the heating surface has to furnish for each pound of exhaust steam condensed and re-evaporated 31 pound-degrees of heat. The power of evaporation from a temperature of 170° being known, that from a natural temperature of 55° is readily calculated. In the former case the boiler has to supply 1219 — 170=1049 pound-degrees, and in the latter 1219 — 55=1164 pound degrees for each pound of water evaporated, and the evaporative efficiency of Messrs. Aveling's boiler with cold feed would thus be $\frac{8.488\times 1049}{1164} = 7.649$ lb. per pound of coal, an efficiency slightly greater than that given by the ordinary form of calculation.

We have dwelt at some little length on this subject, as we have noticed a tendency in some quarters to neglect the fact that the admission of a portion of the exhaust steam to the tank containing the feed not merely heats the latter, but also adds to the quantity of water to be subsequently evaporated. In the case of Messrs. Aveling and Porter's 10-horse engine, 11.4 per cent. of the exhaust steam is thus condensed and a corresponding saving effected in the supply of feed-water to be furnished from other sources. In reality, indeed, the evaporative efficiency of the boiler is even higher, and the consumption of water per horse power greater than we have shown it to be, as the above calculation takes no account of the steam condensed in the steam jacket. In engines constructed like Messrs. Aveling's, Mr. Burrell's, and Messrs. Tuxford's, all the water resulting from the condensation of the steam in the cylinder jacket runs back direct into the boiler, and is re-evaporated, thus saving an equal quantity of feed which would otherwise have to be supplied by the pumps. Owing to the construction of the engine, it is impossible, without the aid of special arrangements, to measure the quantity of steam thus condensed in the jacket; but even with such moderate degrees of expansion as those at which the engines were worked at Wolverhampton, it is probable that it amounts to quite 6 or 8 per cent. of the whole feed, and it is thus well worth taking into consideration.

An interesting fact shown by Table No. II., and one which may at first sight appear difficult to explain satisfactorily is the comparatively small quantity of water used per dynametrical horse power per hour by the engines with unjacketted cylinders. Thus, we find, Messrs. Ransome's engine using less water per dynametrical horse power per hour than Messrs. Aveling's second best engine—an engine which developed considerably more power per pound of coal than Messrs. Ransomes'—while even Messrs. Howard's engine, in which the cylinder is connected to the boiler by a very long and imperfectly protected steam pipe, the quantity of water used per horse power is less than in Messrs. Aveling's engine just referred to. The explanation of this appears to consist in the fact that all the engines with unjacketted cylinders are provided with boilers which superheat the steam to a greater or less extent. Thus the pot boilers are notorious superheaters when working with a strong draught, and in Messrs. Howard's boiler the superheating is also probably very considerable. So far the experiments appear to show that where very moderate degrees of expansion are adopted superheating may efficiently replace steam jacketting, although we ourselves consider the latter to be by far the preferable expedient. This, however, is a matter into the further consideration of which we cannot enter here.

The leading particulars of the competitive engines are all given by us in Table No. I on page 6, while we have appended to the end of this article an outline description, containing such details as we deemed worthy of notice, yet which could not be conveniently stated in the Table.

We must now pass on to describe what has proved in many respects, the most interesting, and certainly by far the most exciting, feature of the present meeting at Wolverhampton, namely, the trials of the traction engines over the course laid down at Barnhurst. These trials have been looked forward to with special interest, from the fact of their being not merely the first held by the Royal Agricultural Society, but the first of a public character, in which engines with Thomson's india-rubber tyres have been brought into competition with engines having tyres of the ordinary kind. There is probably no invention —or rather, perhaps, system of construction—which has been so extravagantly belauded by the non-technical press as these said india-rubber tyres. It has been averred—and that, too, in journals whose editors ought to know better—that these tyres would entirely revolutionise traction engine construction, and it has been stated that road steamers fitted with them had proved themselves capable of traversing easily roads of such a soft and treacherous character as to be utterly impassable for ordinary engines. The very extravagance of many of the statements made caused them to defeat their object, but still enough effect remained to create a very strong belief amongst the general public as to the extraordinary merits of india-rubber tyres. Even the scientific press has in some instances tended to strengthen this belief, although only, we are glad to say, to a very limited extent, whilst we ourselves have repeatedly pointed out the fallacy of many of the statements so freely promulgated by the advocates of such tyres. In making this statement we by no means desire it to be understood that we object to india-rubber tyres *in toto*. In writing on this subject in December last (*vide* page 425 of our tenth volume), we said: "It will be seen that throughout our objections to india-rubber tyres are based principally upon commercial considerations, and there can, we think, be no doubt that, by these considerations alone, the use or disuse of such tyres will ultimately be determined. Our objections, in fact, are urged not against *elastic* tyres, but against tyres formed of such an expensive material as india-rubber now is. . . . That there are certain special circumstances that may warrant the employment of india-rubber tyres we admit; but that for general purposes they are worth the money they cost, we cannot at present believe." The accuracy of these views has been fully substantiated by the trials at Barnhurst, and these trials we must now describe, referring for information respecting the character of the course to the map and sections published by us on page 448 of our last number.

The first proceedings in connexion with these trials took place on Saturday last, when the competitive engines did a preliminary canter over the course without any loads behind them. The engines entered for competition were Messrs. Aveling and Porter's 10-horse engine, and a 6-horse engine by the same firm; Messrs. Ransomes, Sims, and Head's "farm steamer" with india-rubber tyres; Mr. Charles Burrell's 8-horse engine of his usual pattern, and also a Thomson road steamer by the same maker; and, finally, a 10-horse traction engine, constructed by Messrs. Tuxford, which had been employed by Messrs. Amies and Barford for driving their ploughing tackle, and which was entered in their name. Messrs. Howard's 10-horse traction engine, with their safety boiler, was also intended to compete, but it had come to grief in the show-yard, where it had been taken to be tried on the brake, and was in process of being dug out and got into position at the time the trials over the course took place.

The engines being without loads, and the course generally being in very fair condition, the whole of the engines, with one exception, got through the trip without mishap, the times occupied in making the run of 144 chains, or 1.8 miles, being as follows:

Makers' names.	*Class.*	*Time in minutes.*
Aveling and Porter	10-horse	29
Charles Burrell	Thomson's road steamer	28*
" "	" (2nd trip)	15½
Aveling and Porter	6-horse	22¼
Ransomes, Sims, and Head	Farm steamer with india-rubber tyres	24½
" "	" (2nd trial)	23¼
Charles Burrell	8-horse ordinary pattern	22⅝

The only engine which failed to make the trip without accident was Messrs. Tuxford's, which by an error of the steersman was nearly taken down a bank close to the 108th chain post (see map in our last number), and which was only saved from making a serious leap by its leading wheels coming one on each side of a tree, and fixing themselves firmly in its roots. After a severe struggle, resulting in some slight damage, this engine had to be hauled out of its predicament by Messrs. Aveling and Porter's handy little 6-horse engine. Although not entered for competition the little 6-horse engine, made by Messrs. J. Fowler and Co., and illustrated by us on page 3 of the present number, was also run the course on Saturday, and, notwithstanding that it was checked by having to run along steadily behind Messrs. Tuxford's engine for part of the distance, it accomplished the trip in 16½ minutes.

Saturday's proceedings were, however, mere play, and the real earnest work was performed on Monday. Throughout Sunday and Sunday night the rain had been coming down in torrents, and on Monday morning many parts of the course were little better than a treacherous swamp. The ground at Barnhurst is very light, and when saturated with rain it appears to be thoroughly rotten and unreliable. Early on Monday morning it was still raining, but about mid-day, when the competitive engines arrived from Wolverhampton station, where they had been to be weighed, it cleared up a little, and, notwithstanding the unfavourable circumstances, the trials were commenced.

The first engine to make the trip was Messrs. Aveling and Porter's 6-horse engine, of which we have already spoken. As recorded in Table No. III., which contains the leading results of the trips, this engine, although weighing but 5 tons 4 cwt. 2 qr., took a load of 5 tons 10 cwt., and got over the ground in excellent style, accomplishing the distance in 52 min. At starting the wheels were each fitted with six "paddles" and eight spikes, and these were kept on until the 63rd chain post was reached, when they were removed to allow the engine to run better over the hard road which commences at that point. On starting again after a stop of 2½ min., the engine drew its load without any difficulty until the 92nd chain post was reached, where the course passes through a gap in the hedge to the parish road. Here the ground was in a fearfully soft condition, but as the distance to be traversed over it was short, Mr. Aveling did not deem it worth while to apply the paddles, but got over the difficulty by detaching the engine from the wagon, allowing the former to pass over the soft ground unloaded, and then hauling the wagon over by a long chain after the engine had reached firm ground. It is only fair that we should say a word here concerning the admirable generalship displayed by Mr. Aveling in his management of his engines during their trips. Under his experienced guidance no time was lost in dealing with any difficulty which might arise. Everything that was wanted was provided, and every man accompanying the train knew just what he ought to do, and was kept from interfering with the labours of others. The engine, the trip of which we are now describing, was driven—and admirably driven—by William Ilman, a young engine-driver well known at the recent Royal Agricultural Shows from his management of the handy little crane engines, of which Messrs. Aveling and Porter are makers. To return to the trip of the 6-horse engine, however. At about the 112th chain post, after skilfully taking a difficult turn into a gateway, the train arrived at the bottom of a hollow, the side of which rose at an incline of 1 in 12. Here the paddles and spikes were again applied, and the engine, having been attached to the wagon by a long chain, ascended the bank unloaded, and on reaching the top drew the wagon up after it. The pull, however, was a most severe one, and at one time the leading wheels of the engine were lifted and held

* In this trial the steersman was temporarily disabled by a blow on the mouth from an arm of the steering wheel, and a slight delay was the consequence.

TABLE No. II.—SHOWING THE PERFORMANCE OF THE AGRICULTURAL LOCOMOTIVES DURING THE TRIAL ON THE BRAKE.

Reference number to Table No. I.	MAKERS' NAMES.	Dynametrical horse power due to load on brake when running at the nominal speed.	SPEEDS. Nominal speed of the engine in revolutions per minute.	Nominal piston speed in feet per minute.	Mean speed of engine during trial in revolutions per minute.	Mean speed of piston during trial in feet per minute.	PRESSURE. Pressure in boiler during trial in pounds per square inch. Maximum.	Minimum.	Mean.	Mean dynametrical horse power developed during trial.	WORK DONE. Total number of revolutions made by engine.	Actual time run.	Mechanical time run=total number of revolutions÷by nominal speed.	Total number of foot-pounds of work developed during trial.	Foot-pounds of work done per pound of coal consumed.	Foot-pounds of work done per pound of water evaporated.	CONSUMPTION OF STORES. COAL. Total coal consumed=14 lb. per nominal dynametrical horse power.	Coal consumed per dynametrical horse power per hour.	Coal consumed per square foot of firegrate per hour.	WATER. Feed water supplied to engine during trial.	Additional water resulting from condensation of exhaust steam used for heating feed.	Total actual quantity of water evaporated from temperature of feed.	Temperature of feed.	Water evaporated from temperature of feed per pound of coal consumed.	Equivalent quantity of water which the boiler would have been capable of evaporating from feed at 55°.	Water evaporated from temperature of feed per square foot of total heating surface per hour.	Number of square feet of heating surface to evaporate 1 cubic foot of water per hour from temperature of feed.	Quantity of water used per dynametrical horse power per hour exclusive of that derived from the condensation of the portion of the exhaust used for heating feed.	Total quantity of water used per dynametrical horse power per hour.	OIL AND TALLOW. Quantity of oil used during trial.	Quantity of tallow used during trial.	Total quantity of lubricating materials used per dynametrical horse power per hour.	Period of admission expressed in parts of stroke.	Temperature of gases leaving chimney.
		HP.	rev.	ft.	rev.	ft.	lb.	lb.	lb.	HP.	rev.	hrs. m.	hrs. m.	foot-pounds.	foot-lbs.	ft.-lbs.	lb.	lb.	lb.	lb.	lb.	lb.	deg.	lb.	lb.	lb.	sqr. ft.	lb.	lb.	oz.	oz.	oz.	about	deg.
1	Aveling and Porter ...	30	120	240	134.77	269.54	...	...	115	33.7	26,954	3 20	3 44½	222,502,500	529,767	62,412	420	3.73	17.27	3200	365	3565	170	8.488	7.649	17.306	3.61	28.47	31.72	5¾	22	0.246	1/10	500
2	„ „	15	150	250	186.5	311	110	...	105	18.65	28,542	2 33	3 10½	94,198,500	448,464	53,309	210	4.41	19.8	1630	137	1767	140	8.414	7.79	16.21	3.86	34.26	37.12	25½	17	0.9	1/5	410
3	„ „	18	160	266.6	187.25	312.08	118	105	110	21.05	30,429	2 42½	3 10	112,860,000	447,857	53,871	252	4.42	24.58	1880	215	2095	170	8.313	7.49	19.22	3.25	33.1	36.76	24½	...	0.43	1/10	
4	Ransomes, Sims, and Head	24	160	266.6	167.4	279.	115	110	111	25.2	27,118	2 41½	2 49½	134,244,000	399,535	59,400	336	4.96	24.	2260	none	2260	cold	6.72	6.72	19.61	3.76	33.3	33.3	44	...	0.66	...	...
5	Charles Burrell	16	150	300	167.8	335.6	110	91	100	17.8	25,091	2 29½	2 47¼	88,281,600	394,114	48,213	224	5.04	15.58	1650	179	1829	165	8.165	7.39	13.35	4.69	37.09	41.02	18	...	0.4		500
6	J. and F. Howard ...	30	150	300	157.53	315.06	155	...	100	31.44	23,002	2 26	2 33	151,470,000	360,643	59,167	420	5.49	22.77	2560	none	2560	cold	6.09	6.09	12.25	5.1	34.77	34.77					
7	Tuxford and Sons	20	165	330	190.57	381.14	120	85	90	23.11	25,250	2 2	2 21	93,060,000	332,357	43,851	280	5.96	...	2040	105	2145	110	7.285	6.94	...	...	43.4	45.64	11½	...	0.22	...	320
8	Charles Burrell	24	150	250	146.6	244.4	...	...	100	23.57	20,231	2 18	2 15	106,920,000	318,214	53,460	336	6.22	27.8	2000	none	2000	cold	5.95	5.95	18.18	3.44	36.9	36.9	...	...	...	full gear	

quite clear of the ground, the whole weight resting on the driving wheels. The bank having been surmounted, and the wagon coupled up, the engine completed the trip with one brief stop of 1½ min. for steam, and another for introducing a chain between the engine and wagon. The whole performance was a most satisfactory, and—considering the state of the ground—a wonderful one.

Just as Messrs. Aveling and Porter's engine completed their run, a start was made by Messrs. Ransomes, Sims, and Head's engine, steered by Mr. John Head, and taking a load of 5 tons behind it. We should have explained before that owing to the state of the ground the engines were not taken through the hollow at the starting post, the alternative route laid down in the map being adopted. On the rise between the 5th and 10th chain posts, however, Messrs. Ransome's engine came to a stand, but a start was made again, and in about 11 min. the 18th chain post was reached. Here the course passed through a gateway where there had been much traffic, and notwitstanding the alleged suitability of india-rubber tyres for soft ground, the engine stuck. After a stop of 17½ min., and the application of planks, ashes, and much digging, another start was made, and the engine got on well until a stop was made in the public road near the 105th chain post to take in more water. This being accomplished, the engine made the turn into the gateway, and commenced the task of ascending the sides af the hollow already referred to in speaking of Messrs. Aveling and Porter's trip. Here, however, the india-rubber tyres proved utterly useless. They slipped on the ground and the wheel slipped inside them, and notwithstanding the laying down of planks, and much digging and hard work generally, it was 22 min. before the engine without its load had reached the top of the bank.

In the meantime Mr. Burrell's engine of his ordinary pattern had been started, and the ground having partly dried since the morning, it made an excellent run, and overtook Messrs. Ransome's, which had to be taken to one side to allow it to pass. Just after this a regular thunderstorm came on, and the heavy rain soon made the ground worse than ever. The softer the ground got the less the india-rubber tyres seemed to like it, and although Mr. Head, by sticking manfully to his task, managed at last to get his wagon up the bank, yet he then found himself compelled to abandon it, and take his engine home without its load. Even this, however, was not done without numerous stops, the engine having to be regularly dug out several times, and it was not until 4 hours 10 min. after starting that it eventually completed its trip.

The state of the ground after these exploits, and the continued rain, may be imagined, but it can scarcely be adequately described. Mr. Burrell, after witnessing Messrs. Ransome's trip, sensibly withdrew his india-rubber tyre engine from competition, while Messrs. Amies and Barford also withdrew the engine made by Messrs. Tuxford. Thus there only remained Messrs. Aveling and Porter's 10-horse engine, and with this Mr. Aveling determined to make a run notwithstanding all circumstances. At first a load of 10 tons was applied, but this was reduced to 9 tons, and with this load a fair start was made. Shortly after starting a tooth, and subsequently another broke out of one of the wheels of the compensating gear, but these mishaps caused no failure, and with some brief stops

TABLE No. I.—PARTICULARS OF AGRICULTURAL LOCOMOTIVES AT THE WOLVERHAMPTON SHOW.

Reference number.	Makers' Names.	Nominal horse power.	Cylinders. Number.	Cylinders. Diameter.	Cylinders. Stroke.	Description of valve gear.	Boiler. Class.	Boiler. Heating surface. Firebox.	Boiler. Heating surface. Tubes.	Boiler. Heating surface. Total.	Boiler. Firegrate area.	Boiler. Maximum pressure.	Wheels. Driving wheels. Diameter.	Driving wheels. Width of tyres.	Driving wheels. Description of tyres.	Driving wheels. Ratio of gearing. Quick speed.	Driving wheels. Ratio of gearing. Slow speed.	Ldng wheels. Diameter.	Ldng wheels. Width of tyre.	Weight. Weight of engine empty.	Weight. Weight of engine in working order.	Weight. Weight on driving wheels.	Capacity of tanks.	Capacity of coal bunkers.
				in.	in.			sq. ft.	sq. ft.	sq. ft.	sq. ft.	lb.	ft. in.	in.				ft in	in.	tons cwt.	tons cwt.	tons cwt.	gals.	cwt.
1	Aveling and Porter	10	1	10	12	link motion	locomotive	37	169	206	7.3	120	6 0	18	cast iron	17 to 1		3 6	12	10 0	11 4½	8 10½	217	10
2	„ „	6	1	7¾	10	„	„	25	84	109	4.15	110	5 6	10	Adam's india-rubber.	17 to 1		3 6	6	4 5	5 4½	...	105	7
3	„ „	6	1	7¾	10	„	„	25	84	109	4.15	115	5 0	10	wrought iron	17 to 1		3 6	6	4 5	5 4½	...	105	7
4	Ransomes, Sims, and Head ...	8	2	6	10	„	pot boiler	44 box 15.9 pt	76	135.9	5.25	115	5 0	15	india-rubber	9.3 to 1	18.4 to 1	3 6	15	6 5	10 8¾	7 11½	375	12
5	Charles Burrell ...	8	1	9	12	„	locomotive	21	116	137	5.75	110	5 6	14	wrought iron	9 to 1	15 to 1	...	...	6 10	7 15	...	150	10
6	J. and F. Howard...	10	1	10	12	„	Howard's patent	...	209	209	6.0	180	5 6	15	wrought iron	12 to 1		...	...	8 15	11 10	...	250	15
7	Tuxford and Sons...	10	1	9	12	„	locomotive	...	...	...	...	120	5 0	16	wrought iron	11.32 to 1		...	...	8 0	9 10	...	...	...
8	Charles Burrell ...	8	2	6	10	„	pot boiler	43 box 15 pot	52	110	5.25	120	5 0	12	india-rubber	11 to 1	20 to 1	...	...	6 12	8 18½	6 13	250	12

TABLE No. III.—SHOWING THE PERFORMANCE OF THE AGRICULTURAL LOCOMOTIVES DURING THE TRACTION TRIALS AT BARNHURST.
Length of course, 1.8 mile. (*See page 448 of our last number.*

Reference number to Table No. I.	Makers' Names.	Nominal horse power.	Load. Number of wagons.	Load. Gross load in tons.	Load. Load expressed in percentages of weight of engine.	Time and speeds. Total time occupied on trip.	Time and speeds. Aggregate time of stoppages.	Time and speeds. Net time on trip after deducting stops.	Time and speeds. Mean speed in miles per hour, including stops.	Time and speeds. Mean speed in miles per hour, exclusive of stops.	Coal. Quantity of coal used on trip.	Coal. Quantity of coal per mile per ton of load hauled.	Water. Quantity of water used on trip.	Water. Quantity of water used per mile per ton of load hauled.	Ashes and cinders weighed back after trial.	Remarks.
				tns. ct.		h. m.	h. m.	h. m.	mls.	mls.	lb.	lb.	gals.	gals.	lb.	
3	Aveling and Porter	6	1	5 10	105	0 51¼	0 13¾	0 38	2.10	2.94	152	15.35	105	10.6	16	Ground exceedingly wet when the trial was made.
4	Ransomes, Sims, and Head ...	8	1	5 0	48	4 10	...	...	...	...	...	...	...	...	...	This trial was not completed, the engine having to abandon the load after passing over about three-fourths of the length of the course.
5	Charles Burrell ...	8	1	7 0	90	1 1	0 28½	0 32½	1.77	3.32	167	13.25	124	9.84	20	Ground had partially dried when this trial was commenced, but rain came on before it was completed.
1	Aveling and Porter	10	2	9 0	80	1 5	0 25	0 40	1.66	2.7	233	14.38	217	13.4	25	Ground in far worse condition than during any of the previous runs.

for applying and removing spikes, the engine made the run with complete success in 65 minutes. It is extremely difficult to convey in words any adequate idea of this performance. The road had become at many points simply a quagmire, yet the engine got through it all, and took its load fairly, under circumstances where the india-rubber tyre engine, costing nearly twice as much, had utterly failed to take little more than half the load.

Altogether the trials at Barnhurst proved most decisively that a properly constructed agricultural locomotive can be depended upon to move about a farm under any circumstances which may be expected, or are likely to occur in practice. The india-rubber tyre engine failed, not from any fault of Messrs. Ransomes, for the engine is a really splendid piece of work, but simply because it was entirely unfitted for the work it was called upon to perform. We do not deny that there may be situations in which it may be desirable to employ india-rubber tyres in some form or other, but they certainly do not appear to be in any way desirable on farm engines. We have for some time past considered that the best agricultural locomotive for ordinary use is really a light class of engine, such as the 6-horse made by Messrs. Aveling and Porter, and the performances at Barnhurst, and the useful work executed on the heavy land near Stafford by one of these engines, in getting the ploughing tackle into position, has confirmed us in this opinion.

Our notice of the traction engine trials has run to such a length that we can say but little this week concerning the ploughing trials. We, however, give, on page 8, a Table containing the chief results obtained since our last number, and we shall take an early opportunity of describing the various engines and tackle in detail.

Yesterday morning the various traction engines were to start from Wolverhampton and proceed to Stafford by road, each engine being loaded in proportion to its power, and the consumption of fuel being noticed.

(BY TELEGRAPH.)

STAFFORD, Thursday evening.

The following are the chief results of the trip of the traction engines from Wolverhampton to Stafford to-day:

Makers' Names.	Net time on road. hrs.	min.	Consumption Load. tons.	of coals. cwt.	qr.	lb.
Ransomes, Sims, and Head ...	3	35	12	6	1	20
Aveling and Porter (6-horse) ...	4	17	9	3	2	0
„ „ (10-horse) ...	4	20	15	5	1	17
C. Burrell's (ord. pattern) ...	5	10	12	4	3	0
„ (Thomson's patent)...	5	10	12	8	2	0

Burrell's last engine was delayed by a breakdown of one of the wagons hauled. The steam omnibus "Chenab," built by Messrs. Ransomes, Sims, and Head, also made the run under the direction of Lieutenant Crompton. Time occupied 2 hours 30 min.; coals used 5 cwt. 1 qr.

DESCRIPTION OF AGRICULTURAL LOCOMOTIVES.

IN our last number we published detailed descriptions and engravings of the two representative types of traction engines—agricultural locomotives or "farm steamers" we should say—at the Wolverhampton Show; we shall now proceed to describe the rest of the competing engines, of which the leading particulars will be found in Table No. I. on the present page. This Table also contains the corrected weights of the engines in working order, as ascertained on Monday morning on the weigh bridge of the high-level station, Wolverhampton. The reference numbers of the Table are at the same time arranged with regard to the economical efficiency of the various engines during the friction brake trial, or with reference to the quantity of coal used per dynamometrical horse power per hour.

As already stated, Messrs. Aveling and Porter exhibit two light 6-horse traction engines of a similar pattern to their 10-horse engine shown on pages 452 and 453 of our last number, and, as Messrs. Ransomes' engine was also described by us last week, we shall only have to say something here with reference to the engines sent by Mr. Charles Burrell, Messrs. Tuxford and Sons, and Messrs. J. and F. Howard.

No. 5. The 8-horse agricultural locomotive with horizontal boiler, exhibited by Mr. Charles Burrell, of the St. Nicholas Works, Thetford, is of the usual pattern as manufactured in various sizes by this firm. In general arrangement, this engine differs so far from Messrs. Aveling and Porter's well-known type, that the cylinder is arranged on the top of the firebox casing, while the crank shaft is placed near the chimney. The motion from this crank shaft is transmitted to the wheels by means of a countershaft with quick and slow speeds and strong pitch chains on each side, either of these chains being capable of being disconnected, when turning a corner, without stopping the engine. The engine is mounted on volute springs upon the hind or driving axle, and in order that the length of the pitch chains may not be affected by the play of the engine on the springs, these as well as the axle-box guides, are placed not vertically, but inclined backwards at a right angle to the direction of the chains. At the front end, the engine rests by means of a prolonged bracket upon the leading axle; the steering gear, which is of the hand-wheel, worm and sector class, is also carried by this bracket, this arrangement necessitating, of course, the attendance of a second person to manage the engine. The cylinder is steam jacketted, as in all the other traction engines present provided with a boiler of the ordinary locomotive type. For the purpose of heating the feed-water before going into the boiler, the exhaust steam or part of it can be admitted through a throttle valve into a cast-iron pipe leading round the boiler into the water tank which is fitted under the boiler. The coals are carried in a bunker at the trailing end, holding 8 cwt. of coals, while the capacity of the tank is 150 gallons.

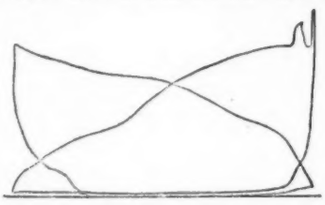
As regards the performance of this engine, some capital work was, as we have stated elsewhere, done last Monday over the traction engine course at Barnhurst Farm. As to the trial on the friction dynamometer, the consumption of coals per horse power would no doubt have been less with a better distribution of steam. The diagrams taken during these latter trial runs, and of which we illustrated a sample on page 449 of our last number, demonstrate clearly that the action of the valve motion might be greatly improved.

No. 6. Messrs. J. and F. Howard's 10-horse engine, fitted with their patent safety boiler, represents certainly a very remarkable type of agricultural locomotive construction. The boiler consists of three sections of 9 in. tubes 5 ft. long, and of two sections of 7 in. tubes of the same length, each of these sections comprising 6 tubes and 7 tubes respectively, making in all 32 tubes arranged horizontally, and communicating with a corresponding number of vertical connexion tubes, as in their marine boiler illustrated by us on page 155 of our last volume. The boiler tubes are made of wrought iron $\frac{1}{16}$ in. thick, and lap-welded; the inclination of the tubes towards the connexion pipes is 1 in 8. Up to the

water level these tubes contain within them, and fixed concentrically, a smaller circulating pipe of 3¼ in. diameter, and provided with slots 1 in. wide, these pipes being introduced to facilitate the circulation of the water, and to enable any sediment to be collected by withdrawing them. To do this, the cast-iron cap, which closes the end of each tube, can be unscrewed.

The cylinder, which is not steam-jacketted, and the motion are arranged above the footplate, at the trailing end of the engine. Beneath the footplate, is a tank holding 250 gallons of water; above the tank, the space is divided, longitudinally, into two partitions, one 1 ft. 7 in. by 6 ft. 4 in. containing, as already mentioned, the cylinder and motion, or the engine proper, the other partition, 2 ft. 4 in. by 6 ft. 4 in., providing room for the engine man and for about 15 cwt. of coals. From the crank shaft, which is placed close to the boiler and just above the fire door, the motion is transmitted to the driving wheels entirely by gearing in the following manner: Upon the driving axle are keyed, on each side of the engine, two discs or driving blocks, one of which receives its motion from the crank shaft by means of countershaft gearing, proportioned in the ratio of 12 to 1. The driving wheels bear against these discs, so that either or both of the wheels can be connected or disconnected to them by means of a pin 2¾ in. in diameter applied at a radius of 9 in. from the wheel centre. The engine is steered from this driver's stand by a small fly wheel and suitable gearing by means of which an endless wire rope can be worked, this wire rope acting, at the leading end, upon a large drum to which the steering wheel is fixed.

We shall probably have something more to say about Messrs. Howard's traction engine, in the meantime we certainly cannot praise it. Even if the form of boiler had been retained—and we cannot say that we consider this boiler adapted for traction engine purposes—the general form of the engine would have been much improved by placing the boiler fully 15 in. lower; the excessive length of the engine, also, might have been reduced by arranging the cylinder in a vertical position behind the boiler. The indicator diagrams,



which we had an oppportunity of inspecting during the trial runs at Wolverhampton, and one of which we reproduce here, illustrate a very considerable loss of pressure from the boiler to the cylinder, due, no doubt, to the great length of piping exposed; but, on the other hand, they show a far less amount of back pressure than we should have expected from the length and arrangement of the exhaust pipe. The engine we should state is fitted with link-motion, and the general design and the workmanship of the engine proper is good.

No. 7. The 10-horse agricultural locomotive, built by Messrs. Tuxford and Sons, of Boston, is of a pattern differing materially from any of the preceding engines of a similar class. In the first place, the driving wheels are placed under the front end of the engine, that is to say, the chimney end, while the steering wheels are arranged behind the firebox; so that, when the engine is propelling a load, the position of the locomotive is reversed as compared with that of an ordinary traction engine. We cannot see what advantages can be claimed by this arrangement, but it is certainly objectionable on the ground that the engine driver is obliged to stand with his back against the direction of the run. Of course the engine is steered by a second attendant, nevertheless, the control over the engine is less perfect than in Burrell's engine, much less so in comparison to Aveling and Porter's arrangement, where the whole machine is completely under the control of one man.

The cylinder, which is 9 in. in diameter by 12 in. stroke, and which is fitted with a steam jacket, is placed in a similar position as in Messrs. Aveling and Porter's standard 10 horse and 6 horse agricultural locomotives; but instead of employing spur gearing, the wheels are driven by pitch chains, as adopted by Mr. Charles Burrell. In this latter case, however, the countershaft is placed across the boiler top, while, in the engine under notice, the crank shaft transmits its motion, by intermediate compensating gear, to a countershaft, which is arranged under the boiler barrel and close to the driving wheels.

The framing of Messrs Tuxford's engine is of a very peculiar construction, which is worthy of special notice here. Instead of the frame plates forming a rigid fixture, they are actually hinged to brackets, fixed on each side of the firebox casing; thus the frame forms, in fact, a lever, having its fulcrum at the said bracket, and to the other extremity of which, near the smoke box, is hung the main weight of the engine, through the intermission of strong volute springs. At the steering wheel end the weight is also carried by springs and we readily acknowledge the attempt of carrying the whole weight upon springs, as a step in the right direction, especially in cases where no elastic tyres are provided for. The feed water, which is carried in a tank which forms a kind of double shell to the smoke box, can be heated by a pipe from the exhaust; the coal is carried in bunkers arranged near the engine driver. The performance of this engine during the trials on the brake is sufficiently explained in the Table, but we should state that—to judge by numerous indicator diagrams, nay, by the mere irregular beat of the engine—the action of the slide valve was sadly deficient.

Mr. Charles Burrell's 8 horse double cylinder road steamer with the vertical "pot boiler" is mounted on three wheels fitted with Thomson's india-rubber tyres, the two driving wheels being 5 ft., and the leading wheel 3 ft. 6 in. in diameter, while the effective width of the tyres, in both cases, is 15 in., and the thickness of the india-rubber ring 4½ in. The main difference of construction between this engine and the one of the same nominal horse power exhibited by Messrs. Ransomes, Sims, and Head, consists in the arrangement of the cylinders. In the latter case, both cylinders are placed in the longitudinal engine axis, as shown by our illustration on page 456 of our last number. Mr. Burrell, on the contrary, fixes his cylinders transversely side by side, but also carried by wrought-iron standards, which at the same time, enclose the engine proper. The motion from the crank shaft is received by a counter shaft, and from there it is transmitted to the annular racks fitted to the inside of the driving wheels. The ratio of gearing can be altered from slow to quick speed, or *vice versâ* by clutch-levers situated by the side of the driver. A flywheel can also be fixed on the side of the engine on the counter shaft, for the purpose of driving, thrashing, or any other class of stationary machinery.

It was at first intended to run this engine on the friction brake, with steam at 130 lb., the boiler, in fact, bearing the imposed hydraulic test of double that pressure without showing any signs of leakage. In the course of the trial runs, however, it became manifest that, with the heavy load of 24 horses on the brake, nothing like that pressure could possibly be maintained, and the engine was run through the trial with a mean boiler pressure of 100 lb. The consumption of coal per dynametrical horse power per hour, as recorded in our Table on the performances, is very high; it would have been less, we have no doubt, with an increased piston speed and a correspondingly reduced load on the brake. It is but fair to mention that both of Mr. Burrell's engines are finished in a very creditable manner.

NOTES FROM PARIS.

PARIS, July 3, 1871.

FINANACES.

THE loan of two milliards has been advanced with an enormous excess, and by a single day's subscriptions. We have no intention of setting up a song of triumph over this great financial success, that would sound false in the actual situation of France; but we are justified in observing how much this easy affluence of capital towards advantageous investment, justifies the hopes of speedy commercial and industrial restoration. Yesterday we feared that the heavy burdens imposed upon the country would for a long time have paralysed all enterprise in trade and industry: to-day we may believe that useful undertakings will still find capital and credit necessary for their prosperity and development.

But we know also better to-day the projects of the imposts and taxes which are required to furnish to the Treasury the increase of income the necessities of the country require. The following are some of the changes which will strike directly upon industry: French and foreign ships arriving from abroad will pay tonnage dues, at the rate of 1 franc per ton. The sugar duty, which is now on an average, 43 francs per 100 kilogrammes, or about70 per cent. of the actual value, will be increased by three-tenths. All raw materials will pay a custom's duty of 20 per cent. ad valorem, the same with all textile fabrics. Beer, wine, alcohol, and tobacco, are attached also in different degrees. The inland postal rates will be raised upon letters of 10 grammes from 20 to 25 centimes; printed matter, samples, &c., now carried at very low rates, will have to submit to great additions. Matches will pay an average tax of 5 centimes per box, which will give, reckoning an annual consumption of 200 millions of boxes, a revenue of 10 millions of francs. There will be established on paper, of which the production is valued at 130 millions of francs per annum, taxes representing 12 per cent. of their value. Petroleum and coal oil will pay on importation duties of from 40 to 55 francs per 100 kilogrammes.

THE IRON AND COAL TRADES.

The iron and coal industries, spared by the project of the budget, and over-excited by a long suspension, are rapidly recovering themselves in all parts of the country; already the quoted prices are rising, as the railways, little by little, are recovering their old activity.

BALANCED MILL STONES.

Last week we noticed an essay by M. Yvon-Villarceau upon the subject of balanced mill stones; we now proceed to give an analysis of the work.

It is known that a mill stone, having been at first balanced in a state of rest, that is to say in such a manner that when in this condition its interior face, which is plain, may be horizontal, this face takes generally an inclination more or less decided, from the time that the stone is revolved around the vertical shaft which passes through the point of suspension. This result, injurious to a good production of flour, is due as much to irregularities in the form of the stone as to any imperfection in the homogeneity of the materials of which it is composed. But it is possible to obviate this inconvenience by arranging certain weights, called by M. Yvon-Villarceau *masses réglantes*, around the stone, and perpendicular to the plane of its lower face.

If the irregularities in form in the distribution of the material in the various points of the stone were known, and could be submitted to calculation, one could determine the position of the adjustment weights by applying formulæ relative to the rotation of a solid body round a fixed point.

But as it is impossible to measure and to submit to calculation the elements of the problem, the only course is to seek in the observed movement of the millstone the measure of its irregularity. The author has proposed to make an analytical study of the movements to find out the nature and extent of the changes in order to fix the position of the compensation weight.

We need not follow the learned mathematician through the development of the analytical methods which he has applied to this difficult subject, but will content ourselves with making known the two processes, and the conclusion to which he has led his calculations. Let us suppose that two of the balance weights are placed in two perpendicular planes. In the plane of one of these weights let us fix on the circumference of the stone a small style, and arrange a fixed vertical surface to receive the impression of the point. The position of the point corresponding to the state of equilibrium of the stone will be noted very distinctly; then if the stone is put into motion, the pointer will trace lines, whose ordinates will be connected with those corresponding to its static equilibrium. The mean of these ordinates is then taken, or if greater exactness is required, the mean ordinate may be calculated. This done, it is easy to calculate how much it will be necessary to shift the weight in a direction perpendicular to the lower face of the stone to nullify this ordinate. It is sufficient to place each weight in two positions to determine the value of its mean ordinate. It will be easily seen in what intermediate position the weight must be placed to obtain an ordinate equal to zero. For the second *masse réglante* a similar process is repeated; the two operations may, however, be conducted together, care being taken to place the two points at different heights, so that their traces on the fixed plane may not be confused.

If conformably to general practice four compensating weights are employed instead of two, it will be sufficient to shift together in equal degrees, and in opposite directions, the two means situated in the same meridional plane.

FOWLER'S TRACTION ENGINE.

WE give on page 3 an engraving of a 6-horse traction engine of a new pattern, exhibited by Messrs. John Fowler and Co., of Leeds, at the Wolverhampton Show. The principal dimensions of the engine are as follows:

		ft.	in.
Diameter of cylinder		0	7½
Stroke		0	10
Heating surface: Tubes	90 sq. ft.		
Firebox	24 „		
Total	114 „		
Firegrate area	3.6 „		
Average steam pressure	100 lb.		
Diameter of driving wheels		5	0
Breadth „ „		1	2

Speed of road motion with engine running at 160 revolutions, quick speed 3 miles per hour, slow speed 1½ miles per hour

Weight of engine in working order ... 7½ tons

It will be seen from the engraving that the engine is carried on three wheels, and in one of the engines of this class exhibited at Wolverhampton the wheels are fitted with india-rubber tyres made up of segments secured on Messrs. Greig and Aveling's plan. The road wheels are driven entirely by gearing, and the crank shaft and countershaft bearings are carried by brackets formed by extending the side plates of the firebox upwards, on Mr. Aveling's system. The water is carried partly in a tank under the boiler, and partly under a tank at the trailing end so as to equalise the weight, and the moving parts are all cased in as shown. One of the engines at Wolverhampton has a double chimney, the hollow sides of this chimney forming a chamber through which the exhaust passes on its way to the blast nozzle. A silent exhaust of a very effective kind is thus obtained. These engines are altogether of a very handy class and they are capable of being run at a high speed if necessary. It was one of these engines which made the quick run round the course on Saturday last, to which we have already referred.

FOREIGN AND COLONIAL NOTES.

The North American Pacific Coast.—Professor Agassiz having had a coast survey steamer placed under his control is examining the waters of the Pacific on the North American coast, and in connexion with deep sea soundings he will collect specimens of natural history.

Omnibuses in Paris.—The revenue of the Parisian Omnibus Company is reviving. In the week ending June 17 the receipts were 12,836*l.*, against 17,958*l.* in the corresponding week of 1870. The number of the company's omnibuses at work was increased in the week ending June 17 to 500.

Road Steamers in Brazil.—Privileges have been granted in the Brazilian province of Rio Grande do Sul for two roads intended for Thomson's road steamers.

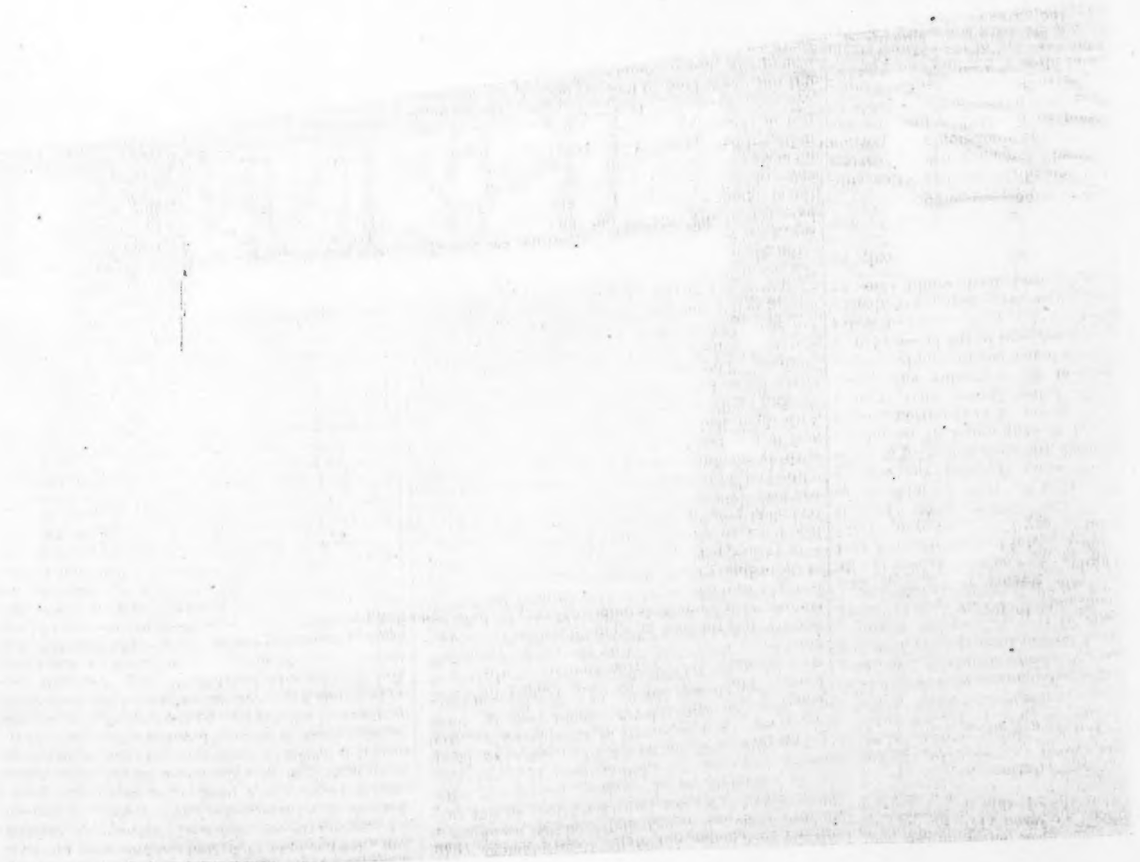
Utah Southern Railroad.—The laying of the rails of the Utah Southern Railroad has been commenced. Brigham Young drove the first spike in the presence of a large concourse of spectators.

Street Railways in Melbourne.—An application has been made to the Melbourne City Council by Mr. M'Millan for authority to introduce street tramways into that city. The matter was referred to the public works committee of the council.

The Belgian Iron Trade.—The state of the Belgian iron trade continues favourable. Almost all descriptions of iron are in good demand, especially plates; considerable quantities of these latter have been sent to Germany. A contract for 2000 tons of rails for the North-West Austrian Railway has been divided between the Thy-le-Château, the Couillet, the Monceau, and the Sclessin Works.

TABLE No. IV.—THE RESULTS OF TRIALS OF PLOUGHING ENGINES AT WOLVERHAMPTON.—(*Continued from Page 451 of our last Number.*)

Reference number to Table No. I. on page 450 of our last number.	Makers' Names.	Class of engine and implements employed.	Time occupied in getting ready for work.	Number of men and boys employed.	Area cultivated.	Time occupied.	Area which would be cultivated in a day of 10 hours, supposing the preceding rate of work to be maintained.	Mean depth of earth acted upon.	Tons of earth moved per acre.	Tons of earth moved per hour.	Coal used per acre.	Coal used per 1000 tons of earth moved.	Coal used during trial.	Water used during trial.	Water used per acre.	Oil used during trial.	Tallow used during trial.	Oil + tallow used per acre.	REMARKS.
			min.		a. r. p.	h. m.	a. r. p.	in.	tons	tons	lb.	lb.	lb.	gal.	gal.	oz.	oz.	oz.	
7	J. and F. Howard	Double drum engine with cross boiler, three anchor pulleys, rope porters, and 5-tine cultivator	19½	4 men 1 boy	1 2 21	1 32	9 0 0	8⅝	1572	1415	208	132.3	624	436	145.3	20	3	7.6	The first portion of this trial was recorded in our last number, a portion of the plot having been cultivated last Wednesday week, and the remainder having been completed on the succeeding day. In giving the quantity of water used, allowance has been made for 80 gallons which leaked from the tank.
,,	,, ,,	,, ,,		,,	1 1 19	1 47½													
3	J. Fowler and Co.	One 8-horse single cylinder engine with double drums, 6-disc travelling anchor, and scarifier.	...	3 men 2 boys	1 0 0	0 39	15 1 21	...	...	...									
3	,, ,,	Same gear as above, but with cultivator in place of scarifier	...	,,	1 0 0	0 38	15 3 6	...	...	...	179	...	537	438	146	6	...	2.	This trial was made for Lord Vernon's prize, and the total time occupied in doing the three acres was 2 hours 26 min., of which 14 min. was occupied in changing the implements.
3	,, ,,	Same gear as above, but with 4-furrow balance plough in place of cultivator	...	,,	1 0 0	0 55	10 3 25	...	...	...									
	,, ,,	Roundabout tackle driven by 12-horse portable engine made by Messrs Clayton and Shuttleworth, and hired by the Society	...	...	3 0 0	3 15	9 0 36	...	...	...	119	...	358	230	77	...	...	...	A portion of the time occupied in this trial was taken up in changing implements, as in the trial next above, so that the work was really performed much more quickly than appears from the time stated.
	J. and F. Howard	Roundabout tackle driven by 10-horse single cylinder engine made by Messrs. Clayton and Shuttleworth	21	...	3 0 0	2 34	11 2 31	7⅛	1480	1729	166	...	598	441	147	7	...	2.3	A delay of 26 min. took place during this trial, owing to one of the main anchors drawing.
	,, ,,	Same tackle, but driven by 12-horse portable engine hired by the Society	31½	...	3 0 0	3 0	10 0 0	...	...	...	162	...	487	313	104	...	...	...	This trial was made for Lord Vernon's prize, and one acre was scarified, one acre cultivated, and one acre ploughed. Several delays were occasioned by the belt slipping. On the conclusion of the trial, a portion of the plot was harrowed and drilled, a harrow 10 ft. wide, and a drill 8 ft. wide, being used.
6	Barrows and Stewart ...	Roundabout tackle driven by 12-horse double cylinder engine	28½	6 men	3 0 0	2 18	11 2 14	9	1747	2278	152	134.7	456	320	107	8	2	3.3	
8	Amies & Barford	Single cylinder traction engine, two of Campain's self-moving anchors, fixed anchors, 9-tine cultivator	...	3 men 2 boys	2 0 32	1 52	10 7 5	6	1188	936	136	...	323	242	102	17	...	7.1	This trial was partially reported in our last number. The total time occupied was 3 hours 9½ min., of which 9½ min. was taken up in changing implements, &c. Part of the three acre lot was found to be utterly unsuitable for ploughing, and a portion was, therefore, at the direction of the judges, left untilled.
8	,, ,,	Same tackle as above, but with 3-furrow plough in place of cultivator	...	,,	0 0 27	1 8	...	7½											
8	,, ,,	Same tackle as above, but driven by Society's engine	67	,,	...	1 38	...	...	...	...	...	87.	275	212	...	...	...	...	
5	Ravensthorpe Engineering Co., Fisken's patent	10-horse double cylinder traction engine with flywheel grooved for fast rope, two travelling windlasses, rope anchors and porters, and 7-tine Fowler's turning cultivator and digger	...	4 men 1 boy	3 0 0	2 16½	13 0 29	8 7½	1458	1923	153	106	458	399	133	22	18½	13.5	This trial was partially reported in our last number. After 1 acre, 2 roods, 8 perches had been cultivated to a depth of 8 in., the tackle was stopped by one of the windlass bearings getting hot and melting out the bush. The remaining 1 acre, 1 rood, 32 perches of the plot was cultivated with a digger the following day to a depth of 7½ in.
5	,, ,,	Same tackle as above, but with a scarifier, cultivator and plough used successively	...	,,	3 0 0	2 37	11 1 34	...	...	...	18¼	105	552	335	112	13½	...	4.5	In this trial one acre was cultivated, one acre scarified, and one acre ploughed.
1	J. Fowler and Co.	Pair of 20-horse single cylinder engines with 9 tine turning cultivator	...	4 men	0 2 16	...	about 20 0 0	6½ to 9	about 1400	abt. 2800	...	...	...	...	...	...	...	...	These were the first trials made on the heavy land near Stafford. The implements worked on a hill-side, one engine being about 60 ft. above the level of the other.
1	,, ,,	Same tackle as above, but with 8-furrow digger in place of cultivator	...	,,	0 3 11	0 24	about 20 0 0	7 to 9¼	about 1460	abt. 2920									



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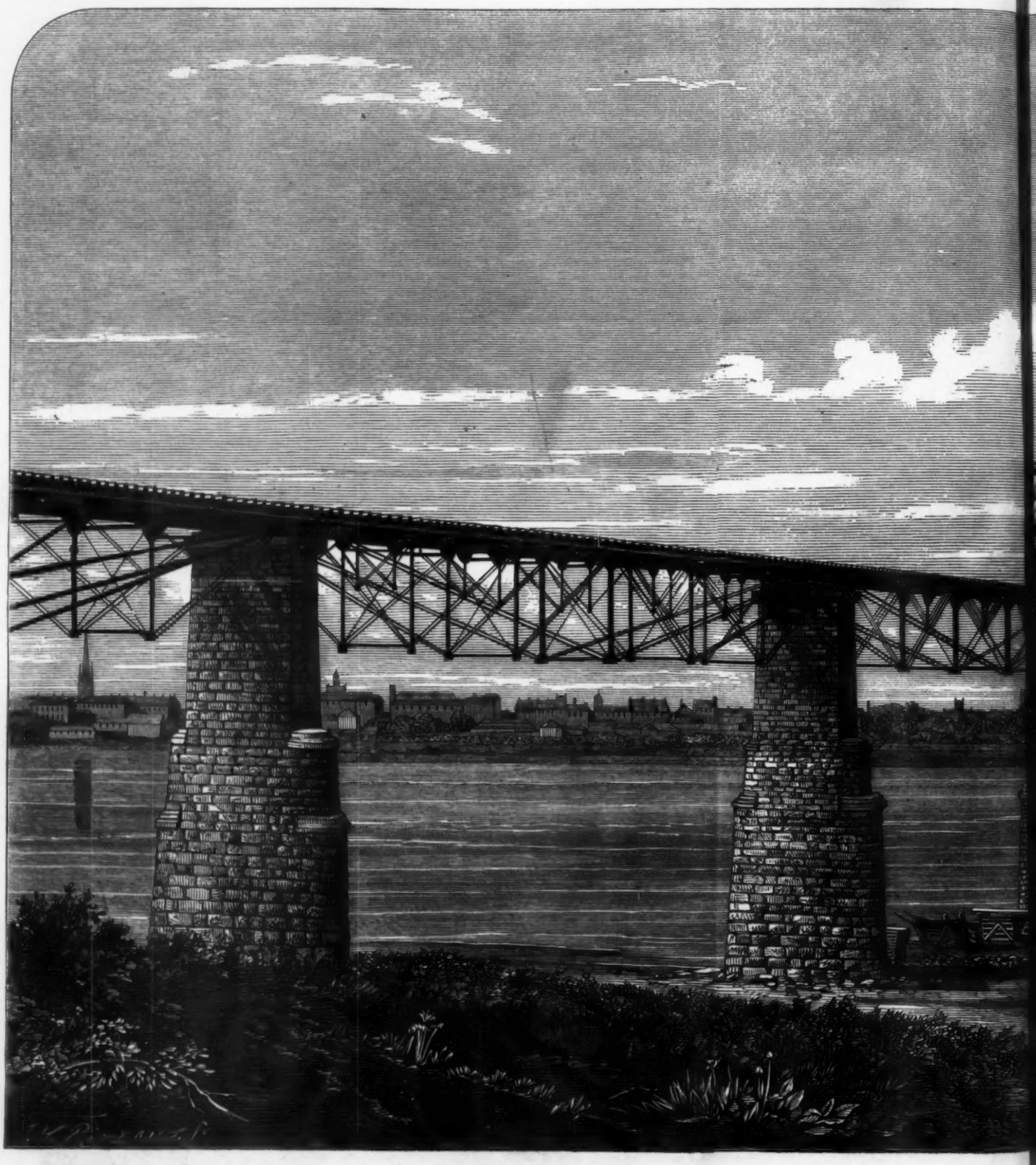
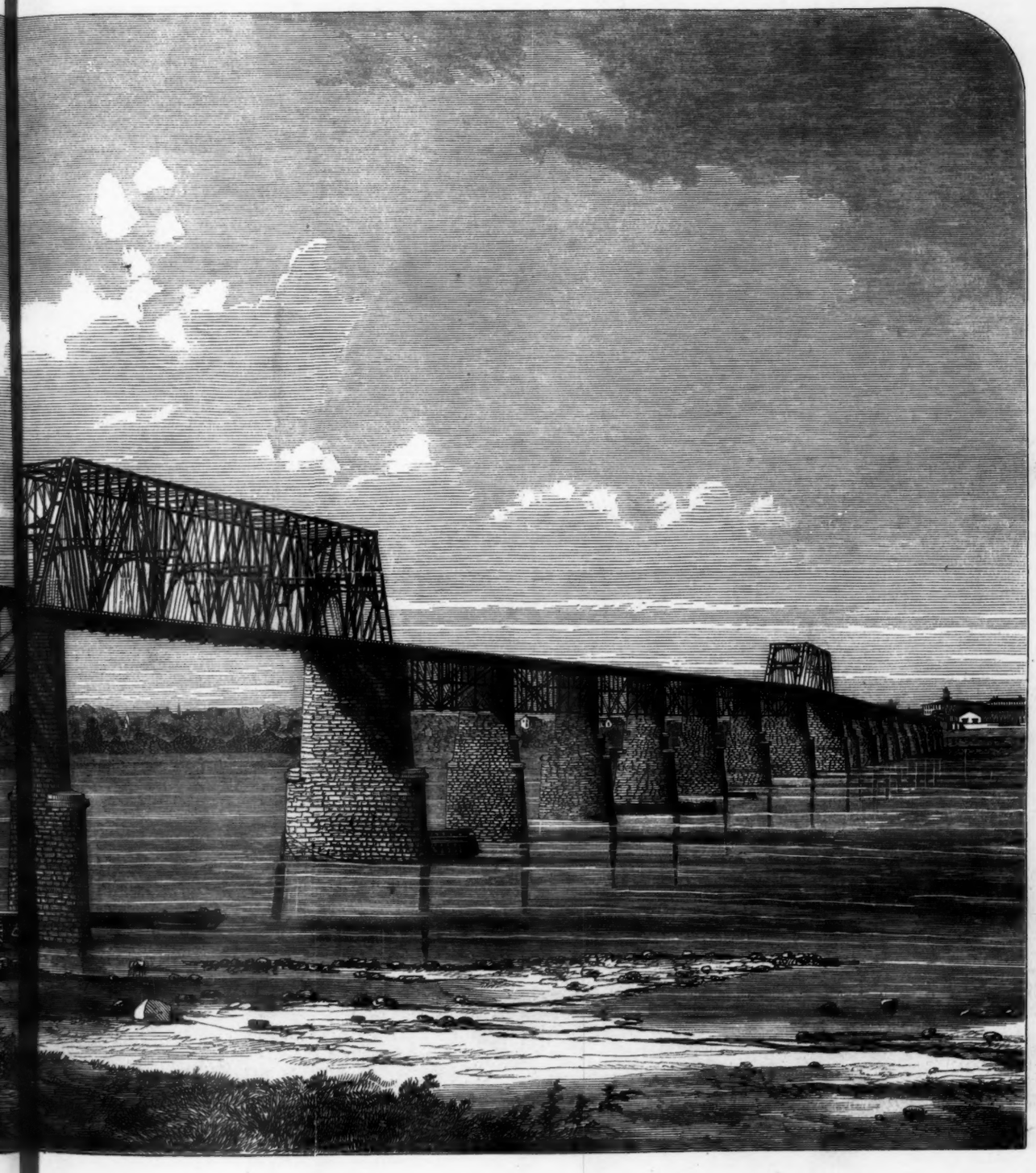


R OHIO AT LOUISVILLE, U.S.A.

ENGINEER.

Page 2.)



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NOTICE TO AMERICAN SUBSCRIBERS.

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of 1l. 14s. 8d. ($8.32, gold) per annum, payable in advance.*

ERRATUM.—In our last article upon the Mont Cenis Tunnel, page 430 of our last volume, line 43, for the word "England" read "Italy."

CONTENTS.

	PAGE		PAGE
Bauschinger's Indicator Experiments on Locomotives	1	Private Bills in Parliament	12
The Louisville Bridge, U.S.A.	2	The Holborn Viaduct Station	12
The Royal Agricultural Society's Show	3	Titanium and Iron	12
Fowler's Traction Engine	7	Compound Engines with Receivers	12
Foreign and Colonial Notes	7	Notes from the South-West	13
Notes from Paris	7	Notes from the North	13
The Metropolitan District Railway	9	Notes from Cleveland and the Northern Counties	13
The Hooghly Bridge	9	Goods Wagon for the Villa Maria and Rio Cuarto Railway	14
Fireproof Building	10	Institution of Civil Engineers	14
Trade Outrages	10	The East River Bridge	15
Literature	10	Copeland's Washing Bowl	16
Mechanical Refinements	11		

ENGINEERING.

FRIDAY, JULY 7, 1871.

THE METROPOLITAN DISTRICT RAILWAY.

THE engineering event of the week has been the opening of the Mansion House Station of the Metropolitan District Railway, and the consequent extension of the line into the centre of the City. We have on so recent an occasion illustrated and described* this last, and really great engineering work—which has been more beset with difficulties than most of the other work on the line—that we need not again refer to its description and arrangement. There remains now only the short length of line eastward, to be constructed, to make a junction with the City terminus of the Metropolitan Railway, and complete the inner circle, as contemplated by Mr. Fowler in 1864. Whether this line will ever be made or not remains to be seen, the financial difficulties in connexion with its construction, which hitherto interfered with its progress, will most probably be removed for some time at all events. So that meantime, although in the obvious fitness of things, the missing link should be supplied, and the Tower Hill Extension built, the Metropolitan Railway must be regarded as complete, but divided into two managements, the Metropolitan proper, carrying its passengers from the west through the northern part of London to the eastern terminus, and the District, accommodating the westerly localities between fashionable Kensington and Westminster, along the Thames Embankment, and so to Queen Victoria-street. Which of these routes will be the most profitable a short time will decide; but it will be a matter for much regret if the two companies should enter into anything like rivalry in their management. Co-operation, not competition, is the only safe course, and neither line can afford to suffer injury or inflict it on the other. Equally it is against their joint interests that there should be separate and independent establishments, separate shops, superintendents, traffic management, and so forth; all these duplicate charges of maintenance will be so much needless burden laid upon the railway. Doubtless these difficulties will be cleared up before long; indeed, the chairman of the District Railway, on the occasion of the opening of the station, stated that the directors of the line he represented are now in cordial co-operation with those of the Metropolitan. In such a case the interest of both companies will be far better secured.

It was a little hard of Mr. Gladstone to allude in his speech last Saturday morning on the same occasion, to "The pleasures of Hope" in connexion with the shareholders in the District Company. He said that these "did not live upon the present, for, on the contrary, they habitually, earnestly, and constantly directed their view into the future." This being the case, the assurance of the chairman must have been extremely welcome, for the anticipation of severe competition with the Metropolitan has been a source of no little anxiety.

But even under the most favourable conditions, there are many whose apprehensions will not permit them to believe that the future of the District Railway is a bright one.

Such sombre views are very excusable when it is considered under what disadvantages the line has hitherto laboured. The term of its completion was delayed to an extent which no one could have imagined, and whilst a vast capital was lying unproductive, the earning capacity of the unfinished line was necessarily limited. After long delays, when the railway was opened as far as Westminster Bridge, there was but a comparatively scanty traffic available, consisting only of those passengers whose business lay between Kensington and Westminster. Then came the tedious period of construction along the Thames Embankment, the backward state of which probably helped to retard the railway, so that for a very long while the Westminster Station formed the terminus. And when the line was opened for traffic as far as Blackfriars there remained the most important length uncompleted, by which the bulk of passengers could be conveyed into the heart of the City. So that up to the present time the line has not had a chance; although the regular increase of passengers upon it, as length by length it was extended citywards, has shown that it will command a large traffic, and one less liable to direct competition than the Metropolitan itself. Besides, there is little doubt, taking into consideration its great length of open cutting, and its more commodious and lighter stations, there will be a tendency on the part of all passengers whose destination is the City, to make use of it rather than of the older and darker railway. Moreover, it accommodates three of the most important districts of London in relation to Kensington, namely, Westminster, the Temple, and the City. In addition, the line will enter into direct and favourable competition with the metropolitan traffic of the South-Eastern Railway, and will absorb a large proportion of the Westminster and City traffic now conveyed by omnibuses. Besides all this there is the special business developed by the ever-growing art and science buildings at South Kensington. The annual exhibitions, the Museums, the schools, all create an increasing traffic of their own, which will help to swell the income of the company.

Taken altogether then, the prospects of the now completed line appear fair, though they are never likely to realise the sanguine expectations in vogue when the railway was promoted, and hopes ran high about metropolitan railways in general. Those hopes have suffered heavy blows since then, and few at the present time dare anticipate 7 per cent. upon their investments. With the enormous cost of railways in the metropolis, such a result is of course impossible. The money spent to obtain permission to make a line, the money spent in acquiring ground upon which to make it, the cost of works, the cost of working after completion, all these items swell into figures, which even the revenue from the inexhaustible throng of passengers cannot gain large interest for.

But if it should happen, even under all its most favourable conditions, that the Metropolitan District Railway should not prove profitable in the end (though this undesirable contingency is, of course, a remote one), the shareholders will have the real satisfaction of knowing that they have provided a most efficient and commodious line of travel, that through their help the crowded streets become less thronged, that the transit of passengers is infinitely facilitated, and that another grand step towards the great London street reform has been accomplished. They will know, moreover, that the construction of the line has involved the destruction of many miserable streets a disgrace to the metropolis, and the dislodgment of hundreds of people a disgrace to the population, and that it has made room for new streets, and fine buildings, so that good has been wrought directly as well as indirectly by the work. All success, then, to the Metropolitan District Railway, completed at last, and to the patient shareholders who have completed it!

* See ENGINEERING, page 190, vol. xi.

THE HOOGHLY BRIDGE.

THE question of bridging the river Hooghly at Calcutta has now been under discussion for about a quarter of a century, and it will doubtless be admitted on all sides that the time must now have arrived when something definite should be decided upon, and a bridge of one sort or another be put in hand. This is a question, it must be remembered, affecting not only the passengers from Calcutta by the East Indian Railway only, but the public of Calcutta generally. Howrah stands towards Calcutta much in the same position as Lambeth does to Westminster, or the Borough to the City, with the exception that there exists no road of communication between the two sides of the river, and in this respect it is perhaps more in the position of Birkenhead to Liverpool, all communication between the two sides of the river being dependent upon boats. Numberless plans for overhead bridges, floating bridges, and subways have from time to time been submitted to Government as means for effecting a safer passage than is possible with the present provisions for transit. Successive Governments have talked, reported, and called for plans, and referred home and done nothing. Two years ago five well-known gentlemen offered to build a floating bridge in eighteen months, if Government would grant them certain reasonable concessions; these gentlemen were Mr. W. Granville, the Government Architect, Mr. F. Prestage, agent of the Eastern Bengal Railway, Mr. B. Leslie, of the East Indian Railway, and Messrs. Stephenson and Purdon, Civil Engineers. The plans and proposals of these gentlemen were sent to Government, and after considerable delay a committee was appointed to report upon their scheme. That report advised that the bridge be made a free one, which of course put a stop to all private enterprise in the matter. Government then undertook to build the bridge themselves, and Mr. Leslie was appointed engineer for carrying out the work; but as there appeared a good prospect of making it a remunerative work by the levy of tolls, that part of the recommendations of the Committee which stated that it should be a free bridge has been disregarded, and a Bill has accordingly been passed to provide for its construction, and the subsequent levy of tolls on passengers and goods. It appears that this is a work which might advantageously have been intrusted to private enterprise to construct, and it has given no small amount of dissatisfaction to those capitalists who were prepared to assist in its construction, and had even offered to do so, that the Government have determined to keep the work in its own hands. If such a work as the Hooghly Bridge be not considered suitable for private enterprise, the question very naturally suggests itself, what sort of work will the Government of India intrust to be carried out by such agency? Irrigation works have over and over again been declared to be unsuited for construction by any other agency than that of the Government itself; it has been given out that all future railways in India will be undertaken by Government; and now a local work such as the Hooghly Bridge has similarly been denied to private enterprise. Is private enterprise, therefore, to be entirely debarred from a participation in the construction of public works in India? or is it to be intrusted only with such works as are not likely to prove remunerative, whilst all of a promising character are reserved for construction on account of the Government? If such be the case, all who would now devote their energies and resources in assisting in the development of India's resources, will assuredly direct their attention to other countries, where they will meet with greater encouragement.

Mr. Leslie having been appointed as engineer for the construction of the bridge has been instructed to proceed to England with the view of superintending the execution of the necessary ironwork in this country. After all the various plans that have from time to time been proposed for this important bridge, economy has apparently been the gauge by

which the design has been settled. It is to be a floating bridge, the more permanent, but at the same time more costly proposals having been rejected on the score of economy in first cost. So far as we understand Mr. Lealie's design, it consists of deep and narrow pontoons placed in pairs with their length in the direction of the stream, and supporting a platform roadway which will connect Calcutta with Howrah. The peculiar shape of the pontoons has been given to them with the view of adapting them to the exceptional circumstances and rapid stream of the river Hooghly; thus their exceptional depth will give them steadiness at the same time that owing to the sharpness of their ends and narrowness, they will offer the least practical resistence to the tidal current which at times runs at a very great speed past Calcutta. We shall hope to give some further particulars relative to this bridge on a future occasion.

FIREPROOF ROOFING.

SOME interesting experiments were recently carried out at the Patent Stone Works of Mr. Frederick Ransome, at Greenwich, in order to ascertain the power of the roof covering lately introduced into this country by Messrs. Erichsen and Co. of Copenhagen, to resist the action of fire.

Two timber sheds had been previously constructed, both precisely similar in size and material employed. Each shed was 10 ft. by 6 ft. square, and 7 ft. high. One of them was covered with slates resting on rafters, the other was covered with the so-called roofing pasteboard. Fuel, consisting of straw and wood, were placed in equal quantities in each hut, and ignited. In the slated roof the slate began to perish 12 minutes after the fuel was lighted, and in 23 minutes it was entirely destroyed. In the mean time the roof of the other shed remained, to all outward appearance, quite perfect, nor was it destroyed when the fire had burnt out, and the whole of the shed had fallen down.

A part of the pasteboard covered roof was also covered with a coating of Ransome's silicious paint, and one of the most interesting results obtained was in reference to this material. Not only did it remain quite untouched by the action of the fire, but the boarding upon which it had been laid resisted the action of the flames to such a degree that, for a quarter of an inch in thickness, the wood was entirely uninjured.

Messrs. Erichsen's covering has already earned a good reputation in Denmark, and will doubtless be appreciated here, but the experiment of the other day pointed out so clearly the advantages attending the use of the silicious paint as a fire-resisting medium, that the greatest publicity ought to be given to its efficiency. We have already pointed out the good service this material renders in waterproofing walls; to a limited extent it has also been employed in covering the woodwork of buildings with the effect of making it almost fireproof. Indeed, so thoroughly reliable is it, that if a piece of timber coated with the substance is placed in a fire and allowed to remain exposed to intense heat it will be found upon removing it that the paint remains as a shell, and intact, the charred wood contracting from it on all sides. With so inexpensive and effective a fireproof medium available, there is every reason for its universal employment, which would be attended with so much increased security of life and property.

TRADE OUTRAGES.

THE contests between labour and capital which are almost unceasing in some one or other of the manufacturing districts, generally assume their most objectionable and outrageous conditions in Sheffield and its vicinity. The recent strike of the steel converters at the Bessemer Works, with the subsequent intimidation and violence, on the part of the men on strike, against the more sensible and better disposed operatives, is another proof of the necessity of some more severe and decided action being taken to protect the interests of employers, and the lives of workmen against such attempts. In the present instance, the most flagrant offenders have indeed been subjected to punishment, which, if it has not the effect of stopping altogether their peculiar mode of argument, will delay, for a time, any further demonstration on their part.

The incident taken altogether is instructive as illustrating the very lowest and commonest type of trade difficulty between employer and employed. A small number of men entertaining an unshared feeling of dissatisfaction, quit their work in a regular manner, but resort to menaces and physical measures to deter other and better disposed men from continuing their labour, threats and violence being especially directed against the labourers who attempt to take their place. The consequence is that the work of a large establishment has been interfered with temporarily, serious inconvenience is experienced, and had the ringleaders in this affair not proceeded to extremities, the annoyance and loss suffered would, of course, have been much greater.

For trade outrages such as these, special measures of severity are required, for the legislation which deals with disputes between employers and employed, is scarcely applicable. It is, to say the least, extremely unreasonable that so much inconvenience should be suffered, without the possibility of remedy, until actual violence has been offered, and that even then, the punishment of the chief offenders should not altogether stop the mischief. There is clearly a class of operatives for which special legislation is, and will be, required, until such time as they are fit to be trusted with the full privilege of the English subject. A coalition of labour against capital is always permissible, and often just, and such coalitions must always exist; they are the natural efforts—sometimes right, sometimes wrong—of the former to place itself more on an equality with the latter; but the mere development of brute force, as the result of a grievance real or alleged, demands the strongest measures for its repression. Such force knows no master but superior force, and were it possible to inflict severe punishment upon all those who sought by menaces to prevent others from continuing at work, we should soon cease to hear of trade outrages such as the recent one at Sheffield.

LITERATURE.

Elementary Principles of Carpentry. By THOMAS TREDGOLD. *Revised from the original edition, and partly rewritten.* By JOHN THOMAS HURST. E. and F. N. Spon: London.

IN justice to Mr. Hurst, we are bound to point out, before proceeding to review this book, that it is very inappropriately named. In the first place, it is something far more than a treatise on elementary carpentry; in the second place, it is the work of Mr. Hurst, not of Mr. Tredgold, although it is based upon that antique, but still standard volume. Hurst's practical carpentry would, then, have been the proper title for this work, and as such doubtless it will be generally known. Not only is the general appearance of the book quite new, with all the old illustrations re-engraved, and very many new ones added, but the chapters upon pillars, bridges, and timber have been re-written. Those on scaffolds, cofferdams, &c., are new; while the whole of the old part has been revised, and changed in its character. Besides one hundred and fifty woodcuts, there are forty-eight excellently engraved plates, and a comprehensive series of Tables. After a chapter upon the equality and distribution of strains, and a second upon the resistance and general properties of timber, the practical portion of the book is commenced by an article upon the construction of floors; and in this section all varieties of construction are considered, and besides actual description, investigation of the comparative value of different arrangements, and the strengths of different forms of beams are given. This chapter is naturally succeeded by another on roofs—a subject of greater interest and of wider scope than the preceding one. Commencing with the simplest form of roof framing—that of two raking rafters meeting at a ridge piece, and tied together by a collar beam—the author proceeds to supply drawings and descriptions of roofs of various sections and for larger spans. A great number of examples of roofs are given, the selections could not have been better chosen, and twenty-eight plates and a number of woodcuts, together with the Tables of scantlings placed at the end of the volume, describe almost all that can be desired by the reader and practical carpenter. Cognate to the subject of roofs is that of domes, and the structure at the Invalides, at the original Halle aux Blé, the dome of which was 129 ft. diameter, and the thickness of its construction 12 in. This building was destroyed by fire in 1803. Its ribs were formed of timbers 9 ft. long, 13 in. wide, and 3 in. thick, framed together upon the system introduced by Philibert de Lorme about 1550. The construction of the 100 ft. domes of the Dublin Exhibition is also described and illustrated.

The section upon scaffolds, staging, and gantries lacks completeness, and this is all the more to be regretted, as it is a subject upon which so little has been written, but on which so much might be said, to the general interest and profit of the profession. It is true that the subject is subsequently considered in some degree in a subsequent chapter, but it is a serious oversight to dismiss in nine pages one of the most important branches of work with which carpentry has to do, the more so, as examples of the best possible kind were ready to hand—examples employed of late years in the construction of many of the recent engineering works. Thus the great gantry, by the aid of which the St. Pancras roof was constructed, was a masterpiece of staging, and a description of it, with sketches, would have proved of high value; we cite this as one example out of many that should have occupied a conspicuous place in the book, but which are not even alluded to. The only detailed description of any work of this kind is that of the staging erected for the construction of the Admiralty pier at Dover. Altogether, we are disappointed at this portion of the book.

The chapter on bridge centres, if somewhat out of date, is of course good. It is much to be regretted, however, that recent examples were not added to supplement the illustration of the practice of early engineers, and that bridge staging should not have found place in this or the preceding chapter.

The section on cofferdams, shoring and strutting is entirely new, and is very good, and the examples selected are well described as regards their detail.

Wooden bridges, viaducts, &c., do not receive so much attention as the importance of the subject deserves. In England where iron entirely replaces the use of timber for such structures, unless they are on a very small scale, the importance of timber is overlooked. But in Norway, Canada, the United States, everywhere in factwhere wood is more easily obtainable than iron, it is of course generally employed. To have collected a number of the best examples of this class of work, and to have given full particulars of their dimensions, their speciality of construction, together with sketches of the leading details, would not have involved much labour, and would have greatly increased the value of the book.

Some of the information not found in the earlier section of the book has place in the chapter on timber fastenings, which is very complete, and is presented in a far more convenient form than the similar part of Tredgold's work. A very long chapter on timber, which will be found of much interest and value, but the length of which appears somewhat excessive, when we remember the scanty space allowed to some of the other subjects, concludes the volume, excepting of course the Tables and Plates. The former include fifteen Tables of scantlings of timber for different purposes, for floors, roofs, bridges, &c., Tables of the strength of pine and oak (not very valuable these), and Tables of specific gravities of timber and general materials; the one last named might have been omitted, as it has nothing to do with timber.

We trust that none of the criticisms we have passed upon this book will be considered as condemning it in any way. On the contrary it is a work that will be widely and very justly esteemed; but it is of course almost impossible in its first edition to achieve completeness. We shall hope to see some of the suggestions we have made acted upon in another edition, and we trust that the author will, in justice to himself, not repeat the error of putting new stuff into an old garment. But until we obtain a second edition of the book, we welcome Hurst's Principles of Carpentry as a most valuable addition to our engineering literature.

An Illustrated Natural History of British Butterflies. By EDWARD NEWMAN, F.L.S., F.Z.S., &c. The figures drawn by George Willis and engraved by John Kirchner. London: William Tweedie. This is a book which can by no possible license be termed an engineering work, and it is one, therefore, which we are scarcely called upon to review. We do notice it, however, and that for three reasons: First, because it is an excellent book of its kind; second, because many of our readers are interested in the subject of which it treats; and third, because in former days we had strong entomological predilections ourselves, and we direct attention to the work as a slight acknowledgment of the pleasure

we have derived from its perusal. Mr. Newman has a most graphic pen, and his efforts to make his book not merely interesting but useful, have been ably supplemented by those of the artist and engraver. The woodcuts by which the work is illustrated are admirable for their fidelity to nature, and for their general execution.

MECHANICAL REFINEMENTS.—No. VII.

TO THE EDITOR OF ENGINEERING.

SIR,—As in this communication I contemplate giving a description of a machine in which the question of intense friction was involved, it may not be out of place to preface it with some of the facts and theories in regard to friction and lubrication which designing and working the machine has called out.

A recent writer says, "that if a wheel mounted on a shaft 1 in. in diameter requires a given amount of power to turn it, it will if mounted on a shaft 2 in. in diameter require exactly twice the power to turn it at the same speed," and claims that there is, therefore, as much again friction in the latter as in the former case, and no doubt nine out of every ten will agree with him.

Now, admitting the proposition to be correct, a brief consideration of the whole facts will show that the conclusion is an erroneous one. When the 2 in. shaft is substituted for the 1 in. one, three things are changed, the frictional surface is doubled, the speed at which the frictional surface would travel would be as two to one, and the leverage the propelling weight would have over the friction only one-half as great. The latter element of itself accounts for all the extra power required, hence the increased frictional surface, or the speed at which the movement takes place, has nothing to do with it.

It is only when we take this view that we can reconcile the facts, that while it requires more power to move a certain weight on large bearings than small ones, no more power is required to move a given weight on a large flat surface than a small one, and if the weight or pressure is excessive then not as much for perfect lubrication is more easily maintained under the large surface.

In the question of area of sliding surfaces another consideration is involved. Supposing a single square inch to remain lubricated working under a pressure of 100 lb. then a surface 1 in. broad by 4 in. long would work equally well under a pressure of 400 lb., but if the latter surface was formed into a square would it not sustain a much greater weight than 400 lb. and work equally well? That it would "we are free to maintain," because the oil in the centre would be more confined. That is, supposing no oil groove was cut along its centre, for that of course would restore it to practically the same condition as the 1 in. by 4 in., and we argue therefrom that the practice of cutting oil channels along the surfaces of slides or on the working sides of boxes is a detriment. In fact, is not the practice of cutting oil grooves of questionable utility any way; are they not by the use of cheap and heavy oils which seem to have instigated their use, soon gummed up and rendered worse than useless?

The slide in the punching machine described in No. IV., which is 9 in. broad, 4 in. thick, and 18 in. long, is simply a fit without gibs or take-up devices of any kind—it was fitted as good as human skill could do it—has no means of oiling except small holes drilled from the oil recesses cast in the slide itself to the sliding surfaces, no oil escapes while the slide is at rest, and the surfaces are perfectly lubricated when in motion.

In the machine shown in the annexed drawings one of the surfaces to be lubricated required special means, and the plan adopted was what, if dealing with water, might be called "hydrostatic pressure," that is, the oil is introduced into a vertical tube, passes along a horizontal canal, then up to the friction surface. This in a year's trial has worked so charmingly as to encourage the belief that it is not half a bad way to lubricate nearly all kinds of bearings, oil holes generous in size can be used, no wicking is required, no dust or dirt can reach the wearing surfaces through the oil holes, as that which will float will remain in the stand pipe, and that which will settle will collect in the bottom of the horizontal canal.

Figs. 1 and 2 represent a forging machine built on the principle of the Patent Nut and Bolt Company's bolt machine, shown in your advertising columns, but immensely stronger and differing in the mechanical construction.

FIG. 1.

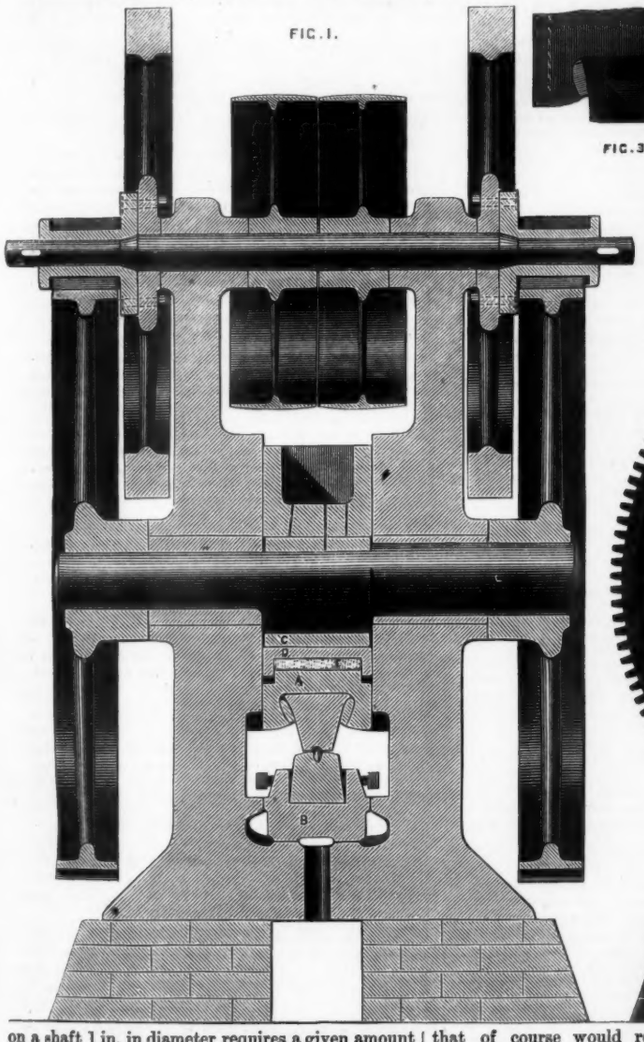
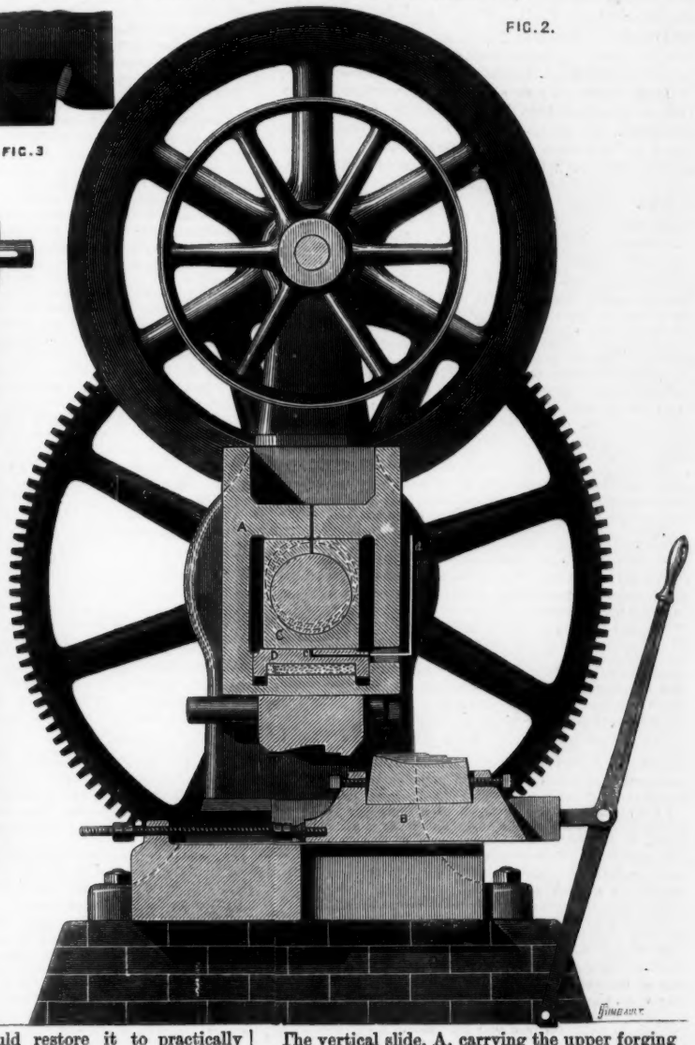


FIG. 3

FIG. 2.



The vertical slide, A, carrying the upper forging die has a vertical motion of only 2½ in., and it will be seen that the main shaft is placed as low as practicable so as to reduce that portion of frame subject to strain to the shortest possible amount. The sliding carriage, B, carrying the lower die is moved in and out by the hand lever, while the slide, A, is at the upper part of its stroke. The entire frame, of which the sides are 8 in. by 24 in., is cast in one piece, the main shaft driven by a gear at each end and an ingenious arrangement devised to cause the gears to drive equally, as will be explained.

It will be seen that the fly-wheels have very thin bosses and are bolted to the driving pinions which fit in a shallow recess to insure perfect truth. Instead of the pinions and wheels being keyed to the shaft in the ordinary way they are secured by friction only, that is, the collars in the ends of the shaft force the pinions against the conical shoulders. As the power of the machine depends on the momentum of the fly-wheels they adjust themselves by slipping

on the shaft. The sliding block, C, which is a substitute for the connecting rod in the bolt machine, has its lower surface lubricated in the manner above described, that is, by the stand pipe, *a*, and holes, *b*, *c*, the surface is about 1 square foot, and though working up to a maximum pressure of 2000 or 3000 tons shows no signs of cutting; the surfaces to commence with were made dead flat. It will be seen that the block works on a false seat, D, having a cavity on its under side fitting over a projection forming a chamber in which is placed a rubber disc, E. This rubber admits of a slight difference in the amount of stock to be forged which is so difficult to get uniform.

Fig. 3 shows the method of securing the upper die and is the most perfect conceivable; both the die and jaws are the strongest possible, the keys adjust themselves so as to bear equally, and cast dies direct from the sand are used. This machine was designed for and has been used especially in forging steel guards for mowing and reaping machines, but is applicable to various other forgings. It is not presented as a work of invention, but a design of concentrated strength and simple construction.

I am yours truly,
AN ENGLISH ENGINEER IN AMERICA.

TITANIUM AND IRON.

TO THE EDITOR OF ENGINEERING.

SIR,—In reply to the remarks of Mr. Forbes, I have never seen "Dana's Mineralogy," so cannot turn to it. It was not known to any person with whom I was acquainted in 1859 that such a statement had been made as that quoted from Dana by Mr. Forbes, showing that immense masses of titanium ore were well known to exist, but my ignorance may be excused, seeing that a professed geologist and mineralogist had fallen into the same error, for it is evident that had Mr. Warington Smythe turned to "Dana's Mineralogy" he would not have informed me, as he did, that I must only expect to be able to obtain titanium ores as cabinet curiosities. Having deoxidised many tons of woots ore and likewise of Elba ore, and having found many of the pieces of both kinds of ore coated with the yellow crystals of amide of titanium, I shall hold to my belief that titanium enters into the composition of these ores, notwithstanding the analyses of Mr. Forbes. The late Mr. J. M. Heath, an intimate friend of my father's, imported about 100 tons of woots ore, which my father smelted for him in the Tintern Abbey Charcoal Blast Furnace before Mr. Forbes was born, unless his years are on the wrong side of forty, and Mr. Heath was aware that this woots ore contained titanium. Mr. Heath also spent six months at the Swedish Iron Works studying the processes, and examining the ores used therein, and he had an analysis of Dannemora iron ore by the late Dr. Ure, showing nearly ¾ per cent. of titanic acid to be contained in that ore, an amount fully sufficient to confer excellence of quality upon the iron smelted from it. The phrase "titanjern malm" is more properly translated titaniferous iron ore than titanic iron ore, and I submit that titaniferous iron ore may be as different from titanium ore as argentiferous lead ore differs from silver ore. Anyhow, no good came of Baron Jarlsberg's importation, nor of the previous importation alluded to in my former letter, so the fact remains unshaken, that I was the first to import titanium ore for useful practical purposes.

I got my ideas of the lack of success in smelting ores of titanium from Mr. Forbes's own statements. Had there not been a lack of practical success the ores of this class would not have been as Forbes states, rejected. I am quite aware of the analyses of ores of titanium by the chemists named by Mr. Forbes, as well as by Rose, Kobell, Rammelsberg, and others, still these gentlemen did not point out the practical value and utility of these ores of titanium, whilst I did so, and that makes an essential difference.

Mr. Forbes has, in a former letter, stated that titanium ores, or if he prefers the title, "titanjern malm" had been smelted in Sweden, Finland, &c., unsuccessfully, and that they were, therefore, rejected positively because they required too much charcoal to reduce them; and inferentially because the excellence of the iron they produced was not so marked as to warrant the extra cost of smelting these ores. This is as much as to confess, that the ironmasters did not understand that although a very large amount of titanium in the ores smelted, was objectionable, nevertheless, a small percentage, i.e., the requisite proportion would insure the production of the best results.

The sole reason why titanium ores, such as the ilmenites of Egersund, were not smelted, but were rejected in Norway, Sweden, and Findland, is the fact that practically they did not answer. Similarly these ores, such as were imported into England previously to the date of my patent, were condemned because they did not answer. I only claim to have made them answer, and to have led other parties to have availed themselves of their utility.

I am, Sir, yours truly,
ROBERT MUSHET.

Cheltenham, June 26, 1871.

THE PEAT CHARCOAL COMPANY.—A prospectus has been issued of the South Wales Peat Charcoal Company (Limited), with a capital of 20,000*l.*, in shares of 5*l.*, to purchase peat works in Glamorgan, and to carry on the manufacture according to the patented processes of Mr. J. J. Hays and others.

COMPOUND ENGINES WITH RECEIVERS.

TO THE EDITOR OF ENGINEERING.

SIR,—A well-known advantage in the use of steam, more easily derivable from the receiver type of compound engine than from other forms, has not lately been noticed, I allude to the facility of obtaining part of the work done in the first cylinder, at the bare cost of its mechanical equivalent of heat; by utilising steam for heating purposes at the approximately constant pressure of the receiver. The proportion of work done in the first cylinder at this, its minimum cost, to the whole work done in that cylinder being obviously the ratio of the heat utilised from, or in, the receiver at its constant pressure, to the whole heat rejected into it from the first cylinder at the same pressure. If the whole volume of steam rejected from the first cylinder could be used for heating purposes, precisely, as if the same volume had been supplied from an independent boiler at that pressure the engine would be wholly non-condensing, with a back pressure in its receiver sufficiently high for effecting the required utilisation, the second cylinder being suppressed. In this case, the whole work done would be obtained, practically at cost of mechanical equivalent of heat plus the loss by external radiation from the engine and receiver.

In an example, here, of an engine with partial utilisation from its receiver, the steam is cut off in both cylinders at one-third of the stroke,* the pressures being in boilers 100 lb. receiver usually 12 lb. (with an oscillation through a range of about 1 lb. the cranks being at 90°), and in the second cylinder 1¼ lb. below the pressure in receiver at commencement of cut off. The receiver is between three and four times the capacity of the second cylinder and is very effectually protected from external radiation, by 14 in. of light ashes, the actual loss being probably less than $\frac{1}{360}$th of the heat passing through it. Of course it is not jacketted or otherwise heated, the object being to get as much heat as can possibly be turned to account out of it. For this purpose beside supplying the wash-houses and drying rooms from the receiver, the feed, from the hot well, was for about two years, raised to the temperature due to the pressure of the receiver, by being injected into it, all not actually used being held back by an arrangement of escape valve, in which the heated feed not required re-entered the receiver to the exclusion of the injection; the deposit, however, could not altogether be got to take place in the receiver, and, together with a defect in the pump itself, caused so much trouble, that it had to be abandoned for the present arrangement, in which all the condensations trapped in the receiver, from the jackets and slide cases of both cylinders, and separated from the exhaust of the first cylinder are merely pumped in conjunction with the feed, used from the hot well, into the boilers; the temperature of the whole averaging but little over 100° Fahr. It is necessary to add, that owing to absence of priming, no lubricant for the pistons and slides is ever used, or required, beyond that furnished by the saturated steam itself.

I am, Sir, your obedient Servant,
W. M. PARR, Superintendent.
Norwich Steam Power Company, Norwich, July, 1871.

* The stroke of both cylinders is the same, 7 ft.

PRIVATE BILLS IN PARLIAMENT.

YESTERDAY week, in the House of Lords, the royal assent was given by Commission to the following Bills: The Lancashire, Yorkshire, and London and North-Western Railway Companies; the Kingston and Eardisley Railway; the Sidmouth Railway; the Midland Great Western Railway (Ireland); the Fleetwood Dock; the Merionethshire Railway; the Albert Bridge; the Glasgow and Great Western Railway; the East and West Junction Railway; the Pontypool, Caerleon, and Newport Railway; the Scarborough and Whitby Railway; the Midland Railway; the Dublin Tramways; the Edinburgh Street Tramways; the Whitehaven Dock and Railway; the Greenock Street Tramways; the Minehead Railway; and the Sutherland and Caithness Railway Bills.

Since our last report the following Bills have been read a third time and passed in the House of Lords: The Clyde and Cumbrae Lighthouses; the Waterford and Wexford Railway; the Dublin Main Drainage; the Columbia Market Approaches and Tramways; the Southampton Docks; the Bristol and Portishead Pier and Railway (Portishead Docks); and the London, Chatham, and Dover Railway Bills.

In the House of Commons the Lords amendments to the following Bills have been agreed to:—The Bristol and Exeter Railway; the Great Southern and Western and Cork and Limerick direct railway companies; the North British Railway; the Vale of Clyde Tramways Bills; the Brecon and Merthyr Tydfil Junction Railway; the Great Western Railway (Steam Vessels); the London and North-Western Railway; the Mitcheldearn Road and Whimsey Railway; the North-Eastern Railway, and the Aldborough Harbour and Railway Bills. The Margate pier and Harbour Bill was read a third time and passed on Monday last.

On Friday last the House of Lords Standing Order Committee reported that the Standing Orders not complied with in the case of the Southern Railway Bill ought to be dispensed with, provided that Clause 10 be struck out. This is a Bill to extend the time for compulsory purchase of land and the completion of works, and for acquiring running powers and entering into working arrangements with the Great Western and the Great Southern and Western Railway Companies.

On Tuesday before the House of Commons Committees, the preamble was proved, and reported without amendment, of the Letterkenny Railway Bill. The object of this Bill is to extend the time for the completion of the railway; to enable the company to borrow from the Public Works Loan Commissioners; and to convert their contractors' bonds into preference shares. The preamble was also proved, and reported with amendment, of the Leominster and Kington Railway Bill. This is a Bill to authorise this company to construct a branch railway to Presteign, to lease the same to the Great Western Railway, and to alter and vary the terms and conditions of the existing lease of their railway to the Great Western. The length of this proposed line is 5 miles 32 chains, and the capital proposed to be raised is by shares 40,000*l.*, and by loan 13,000*l.* The preambles of both these Bills have been already proved before the House of Lords.

On Wednesday, before the House of Lords Committees, the opposition to the Great Western Railway Bill was withdrawn. This is a short new line of 73 chains, and the object of the Bill is to authorise the company to construct junction railways at Cardiff and Swansea, &c., and to extend time for compulsory purchase of lands. The opposition was also withdrawn to the Lancashire and Yorkshire Railway (new works and additional powers) Bill. This is a Bill to authorise the Lancashire and Yorkshire Railway Company to construct a railway from the terminus at Chatburn to the North-Western Railway at the Hellifield Station, a railway from their Blackburn line in the township of Little Bolton, to near the Sharples Bleach Works; and a branch railway from their line at Heap to the River Roach, and at the Bridge Hall Paper Mills; to acquire additional land at Salford; to purchase the district church of St. George in Manchester, and to establish a superannuation fund for their officers and servants. The length of the new line is to be 13 miles 60 chains, and the capital proposed is to be by shares, 436,000*l.*, and by loan, 145,000*l.*

Yesterday before the House of Lords Committees the opposition was eventually withdrawn to the London and Aylesbury Railway Bill. This is a Bill to incorporate a company for making a railway from the Aylesbury and Buckingham Railway at Aylesbury to the Watford and Rickmansworth Railway at Rickmansworth, to use the existing station and railway at Aylesbury, and a portion of the railway and station at Rickmansworth, and to enter into arrangements with the London and North-Western, and the Aylesbury, and Buckingham Railway Companies. The length of the proposed line is 21 miles 1 chain, and the capital proposed to be raised is to be by shares 125,000*l.* and by loan 41,000*l.*

THE HOLBORN VIADUCT STATION.

THE carrying out of Charles Pearson's scheme of underground railways has given rise to improvements in London that seem to have no end. Every day discloses some engineering device to afford the population of the great metropolis and its vast suburbs the opportunity of economising both time and shoe leather. Already locomotion is so cheap that it becomes an absolute extravagance to walk. There is a station at nearly every door of London's surroundings, and the inhabitants are, in tens of thousands, daily whirled to and from the busy centre in almost less time than it takes to record the fact. Still improvements go on, and no project, perhaps, is more entitled to come under that category than the one just passed by Parliament, granting powers for the erection of a commodious railway station close to the Holborn Viaduct It is impossible to over-rate the accommodation that such a station would be to the public. Messrs. T. Marr Johnson and W. Mills, the engineers, fix its site on the now open space immediately south, and on the east side, of the Viaduct, and propose to construct it upon improved principles, with the view of affording equal accommodation to all the companies running through it, and that it should cover an area of three acres of ground. The line will commence by a junction with the London, Chatham, and Dover lines at Ludgate-hill, and terminate at the Viaduct, with the platforms not more than 6 in. off the level of the Viaduct. This great advantage is derived from the fact that Ludgate-hill Station is within a foot or two of the same level as the viaduct. The station will be built to suit what is technically known as the short and the long traffic, and will give special facilities to the London, Chatham, and Dover Company to run directly to Moorgate-street, by passing underneath the Metropolitan station. At the same time, it is not proposed to discontinue the present arrangement with this company to run into the Metropolitan stations, nor in any way to interfere with the traffic now going on. The new station will have a register office, so that foreign luggage can be booked through—say from London to Paris—booking-offices, waiting rooms, general offices, three platforms for local traffic, 330 ft. long, and for long traffic there will be two arrival platforms, each 500 ft. long, and an independent departure platform, also 500 ft. long, as well as extensive cellarage for the storing of ale, stout, and other merchandise. There will also be a cab rank long enough to stand at least 20 cabs; whilst the entrances and exits upon the level of the viaduct will be so constructed as to facilitate arrivals and departures without confusion. In a word, this station will form a kind of feeder to every railway converging to this centre. The estimated cost of constructing the piece of line between Ludgate-hill and the station and the building of the station itself, including special accommodation for the South-Western Company, is 400,000*l.* This sum will be raised entirely by an independent company, and all railway companies running into the station will have to pay a rental for this privilege.—*Standard.*

IRRIGATION IN PERU.—The Peruvian Government having been authorised by virtue of a law of January 23, 1871, to invest 2,000,000*l.* in works for irrigation purposes, has advertised for tenders with a view to the irrigation of the Valley of Azapa in the Department of Moquegua.

AMERICAN PATENTS.—The issue of patents this year by the United States Patents Department is expected to exceed that of former years. Messrs. J. R. Ely, W. P. Wietzel, and Cameron Burnside, of Pennsylvania, have applied for letters patent to protect an invention relating to the manufacture of steel. Several Pennsylvanian steel manufacturers threatened to oppose the application.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday, the quarterly meeting of the iron and allied trades was held in the Royal Exchange, Middlesbrough. The attendance was large. There was a brisk inquiry for pig iron. The market was firm and closed at last week's rates, viz., No. 1, 51s. 6d.; No. 2, 50s. 6d.; No. 3, 48s.; and No. 4, 47s. The usual facilities were given to gentlemen wishing to exhibit models, machinery, and articles of interest to the trade. There were, however, very few exhibitors. One of Mr. Fletcher's (Warrington) gas furnaces for dentists, photographers, and the workers in the precious metals was shown. This furnace is most compact and convenient. It is only 6 in. in diameter and 9 in. high. The speciality is the burner, the flame of which is solid to the centre. It will melt 8 lb. of zinc in an iron ladle in 15 minutes. Mr. J. Johnson of West Hartlepool exhibited a number of paints of various colours which he makes from shale. Photographs and diagrams of Steen's standard weighing machine were shown by Mr. W. Warner, of Middlesbrough; H. P. Boyd and Company, of Low Walker, exhibited a case of screws, and Mr. Thomas Whitwell, of South Stockton, again showed a model and diagrams of his patent hot blast furnace.

The Finished Iron Trade.—All branches of the finished iron trade are in a satisfactory condition. The inquiries for rails continue very numerous.

Engineering.—Generally throughout the North of England engineering is brisk, but it is rather singular that the bridge builders have so little work on hand. Marine and locomotive engine builders have a fair share of orders, and those who fit up iron works plant are very busy.

More New Works on Tees-side.—Within the past week another new company has been formed for the purpose of erecting iron works at Stockton-on-Tees. The company is to be called the Tees Bridge Iron Company, and will erect and conduct two huge blast furnaces on a site in Bowesfield, Stockton. The land which will be occupied is that which some of the London daily papers erroneously announced as having been purchased by M. Schneider, the French iron-master, and which we contradicted at the time.

Strike of Blast Furnacemen at Middlesbrough.—The blast furnacemen in the employ of Mr. Thomas Vaughan, of Middlesbrough, the owner of the South Bank and Clay-lane blast furnaces, sixteen in number, at Eston, struck for an advance of wages last Friday. They wished an increase of 9d. per shift, Mr. Vaughan offered them the following rates per shift: Keepers, 7s. 6d.; chargers, 5s. 6d; slaggers, 4s. 7d.; and mine fillers, 4s. 5d. They refused to accept these terms, and, consequently, the whole of the furnaces were damped down on Friday. Yesterday, Mr. Vaughan had an interview with the men, and he informs our representative that they agreed to resume work that night. To-day, some of the furnaces are in blast, but the whole of the men have not yet returned to their places.

The Nine Hours' Movement at Newcastle-on-Tyne.—The men in the engineering trade are still on strike for the nine hours' movement at Newcastle. On Monday several of the masters opened their works for the purpose of giving the men an opportunity of returning on the old terms if they felt disposed. We have not heard of any of the men embracing this opportunity. In fact, on Saturday, at another mass meeting at Newcastle, the men resolved to adhere to their determination of fighting until they got the nine hours' system adopted.

NOTES FROM THE SOUTH-WEST.

Bristol Wagon Works Company (Limited).—At the sixth ordinary general meeting of the shareholders of this company the chairman (Mr. J. D. Weston) stated that the net profit realised during the past year was equal to 9 per cent. on the share capital of the company, but, owing to a great part of this being taken up in making good a loss sustained in the previous year, the directors were only able to declare a dividend at the rate of 2½ per cent. A proposal that all the works of the company should be at Lawrence-hill, and that its new warehouses and show-rooms should be in Victoria-street would enable the company to combine the management, possess more commodious premises, and utilise the machinery it has at Lawrence-hill, machinery, which, under existing circumstances, was occasionally out of use. The chairman estimated the savings in rental alone at 200*l.* per annum. The report and accounts were adopted, and dividends were declared at the rate of 2½ per cent. per annum on the ordinary shares, and 5 per cent. on the preference shares.

Pontypool Town Forge.—Messrs. Richards and James took possession of these works on Saturday. The works may thus be expected to be shortly again turning out rails of superior quality.

Trade at Swansea.—A coal and metal market was held at Swansea on Saturday. Tin-plate makers were stated to be well supplied with orders. The Hirwain Iron Works will probably be started again shortly. A sample of "iron paper" rolled out at the Landore Tin-plate Works was exhibited at Saturday's market; it was of remarkable surface and thinness. The general condition of the staple trades of the Swansea district continues satisfactory.

Pembroke Dock.—Her Majesty's composite double screw gunboat Coquette launched a short time since from Pembroke Dockyard, having had her machinery fitted, has left for Plymouth where she will be put in commission.

State of Trade at Merthyr.—The iron works in the Merthyr district continue busily employed. The coal trade is, however, in by no means a satisfactory state in consequence of the unsettled condition of the labour market.

Ebbw Vale Steel, Iron, and Coal Company (Limited).—At the fourth ordinary general meeting of the proprietors in this company, Mr. Curtis, the chairman, stated that a greater portion of the outlay made at Ebbw Vale had been incurred for a new rolling mill for steel rails; a new set of three five-ton converters in one pit with the necessary appliances; a steam engine for forcing air into the converters; and a blast furnace with Cowper's stoves for heating the air. In carrying out the works, the directors had laid down a tramroad which would take coal direct from the mines to the converters and steam engines; and by this arrangement he calculated that the company would save from 400*l.* to 500*l.* per month. A large blowing engine had recently been put up at Aberyschan and worked admirably. The directors proposed to increase the company's appliances for the production of Bessemer steel rails. It was also proposed to erect a large blast furnace at Ebbw Vale to replace one worn out.

Railway Iron for Peru.—The Conference cleared on Monday for Mollendo and Callao with 1150 tons of railway iron supplied by the Aberdare Iron Company.

Welsh Shipping Movements.—The Henry Broand, screw steamer, has cleared from Newport for Stettin with 800 tons of coal supplied by the Tredegar Iron Company. The Lebanon, screw steamer, has cleared from Swansea for Valencia with 1000 tons of patent fuel. The Royal Highness has cleared from Pacas, Mayo, and Chinchas, with 1660 tons of railway iron supplied by the Aberdare Iron Company. The Bavelaw has cleared from Cardiff for New York with 1400 tons of railway iron supplied by Mr. R. Crawshay. The Abbey Craig has cleared from Cardiff for New York with 570 tons of railway iron supplied by the Rhymney Iron Company. The Anevoca has cleared from Cardiff for New Orleans with 800 tons of railway iron supplied by the Dowlais Iron Company. The Abram Young has cleared from Cardiff for New York with 1000 tons of railway iron supplied by the Aberdare Iron Company. The Eden has cleared from Cardiff for Valparaiso with 516 tons of railway iron supplied by the Aberdare Iron Company. The Thomas Hamlin has cleared from Cardiff for Montreal with 500 tons of railway iron supplied by the Rhymney Iron Company and 500 tons of railway iron supplied by Messrs. Wayne and Co. The Peter Crerar has cleared from Newport for Baltimore with 900 tons of iron supplied by the Ebbw Vale Iron Company. The Nimbas has cleared from Newport for New York with 1750 tons of iron supplied by the Blaenavon Iron Company. The Colin E. M'Neil has cleared from Newport for New York with 583 tons of iron supplied by the Ebbw Vale Company. The Pomona has cleared from Cardiff for New York with 670 tons of railway iron supplied by the Aberdare Iron Company. The Lorata has cleared from Newport for Talcahuano with 1150 tons of iron supplied by the Ebbw Vale Company.

West of England and South Wales Coal and Metal Markets.—Hematite pig has been firmly held at Newport, and prices are well maintained with a tendency upwards. Hematite ore is also selling at high rates. At the last market at Newport, Mr. Roper exhibited samples of a new variety of Spanish ore from the north of Spain, of which the following is an analysis: Peroxide of iron, 93.58 per cent.; silica, 3.21 per cent.; alumina, 0.80 per cent.; lime, 0.74 per cent.; water, 2.06 per cent.; and sulphuric acid, 0.19 per cent. He also exhibited samples of zinc blende from Pontpean, Brittany.

Rhymney Railway.—The Llancaich Junction of the Rhymney Railway is nearly completed, and facilities are expected to be shortly afforded to enable the Rhymney Company to run trains from Llancaich to Aberdare and Hirwain, thus establishing a direct route between Aberdare and Cardiff otherwise than by the Taff Vale Railway.

The Port of Cardiff.—The quantity of coal exported from Cardiff in June to foreign ports amounted to 127,906 tons. The exports of coke comprised 223 tons. The exports of coal coastwise from Cardiff amounted in June to 58,625 tons, and those of coke to 53 tons. The exports of patent fuel to foreign ports in June amounted to 9251 tons; and those made coastwise were 2003 tons. The exports of iron from Cardiff in June amounted to 18,259 tons. In this total Halifax, Nova Scotia, figured for 1000 tons; Montreal, for 1219 tons; New York, for 10,386 tons; and Valparaiso, for 1210 tons. In the coal exports Constantinople figured for 3434 tons; Havre, for 3195 tons; Rio de Janeiro, for 3264 tons; and St. Nazaire, for 4823 tons.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—At the close of the market this day week 57s. 6d. one month, and 57s. 3d. cash were accepted. On the following day there was very little alteration in prices, but the market still remained firm; on Friday, however, there was a very strong market, especially at the close, and prices went up to 57s. 7d. cash, and 57s. 11d. one month. There was a further advance on Monday, but at the close the market was easier, and 57s. 11d. cash, and 58s. 3d. one month were the prices asked. The same prices were paid yesterday. To-day's market has been quiet, sellers 57s. 10d. prompt, and 58s. 1½d. one month, buyers 1d. per ton less. The return of shipments for last week is again unprecedently good, showing a very large increase as compared with this time last year, being—foreign, 10,747 tons, coastwise, 7142 tons, total, 17,889 tons. Same week last year, 12,880, increase for week, 5009 tons. Total shipments for 1871, 393,520 tons, for 1870, 335,693 tons, showing that the quantity of iron sent away from Scotch ports up to this date exceeds that exported last year by the large amount of 57,827 tons. Several makers advanced the price of their iron last week, and the excessive shipments, coupled with the general prosperous state of the iron trade, caused a number of the makers again to raise their prices on Monday. Coltness No. 1 is now quoted at 66s., being 1s. advance; Gartsherrie No. 1, 64s. 6d., being also 1s. up; Eglinton No. 1, 57s. 6d., No. 3, 56s. 6d., both 6d. up; Langloan, No. 1, 62s. 1s. up; Carnbroe, No. 1, 60s. 6d., No. 3, 57s. 6d., both 1s. up; Glengarnock, No. 1, 61s., No. 3, 58s. 1s. up; Dalmellington, No. 1, 57s. 6d., 6d. up; Quarter, No. 1, 58s. 6d., 1s. up; Chapelhall No. 1, 60s., 1s. up. A movement has been originated amongst a number of the members of the "iron ring" to allow Carron iron to be sent into store as G. M. B., and with this object a document has been extensively signed by the iron brokers, agreeing that after the 1st of January, 1872, they will take in implement of their contracts Carron iron as G. M. B. It is supposed that if this proposal is carried out, of which there is little doubt, it will have a beneficial effect on the trade. The number of furnaces in blast in Scotland is 128, while the number in blast at this time last year was 133.

The Finished Iron Trade.—Termination of the Strike at Motherwell.—After entailing great misery amongst a large portion of the puddlers and their wives and families, this unfortunate dispute, which originated from the fact of a union man named Hodge having been dismissed from the employment of the Glasgow Iron Company, has been brought to a termination by Hodge leaving the district. Considerable feeling still exists between the men who came out on strike and those who remained working and obtained the advance of wages claimed during the struggle, viz., 6d. per ton for taking the iron from the furnace to the hammer. Last night one of the former, named Abraham Smith, committed a most unprovoked assault upon a workman named Jones, who had continued at work, by seizing him by the throat and throwing him to the ground within the works. Smith was apprehended this morning, and conveyed to Hamilton. He is an old offender. Last night a number of the furnaces were fired up by the men that had agreed to resume work, but it will be some time before the works are again in full swing, as a number of the workmen having been disappointed in obtaining the support promised have left the district. At the other works there is a brisk state of affairs, as the orders cannot be implemented fast enough. The chief demand is still for plates, chiefly for shipbuilding purposes, although the orders for boiler plates are also very numerous. Bars, angle iron, and tin plates are freely asked for at very fair rates. Common bars are quoted at 7*l.* 15s. to 8*l.* per ton; rods at 8*l.*; angle iron at 8*l.* 10s.; ship plates at 10*l.* to 10*l.* 10s.; boiler plates at 10*l.* 10s. to 11*l.*

The Ironfounding Trade.—This branch of trade is also very busy, more especially in the department of heavy castings such as are required for marine engines, sugar mills, &c. One large shop is quite stocked with such work—steam cylinders, condensers, sugar-mill rollers, sugar pans, &c.—for London, Glasgow, and other Clyde firms. Some of the castings are 15, 18, 20, or more tons in weight. A large amount of work is also being done in Glasgow in the manufacture of ornamental cast-iron mantelpieces, especially for England and Ireland. One firm recently sent out no fewer than 600 in one week. An order for 26,000 tons of cast-iron pipes for Odessa has just come to the Glasgow market; and it is reported that a large order for chairs has also been received from Egypt. Several large orders for oil works have lately been completed, amongst which may be mentioned some gigantic pans cast by Mr. Tennant, Whifflet, for the Coatbridge Oil Company.

Extension of Messrs. Tod and McGregor's Shipbuilding Yard.—Messrs. Tod and McGregor are just now adding about 20,000 square yards to their shipbuilding yard at Meadowside, near Partick, making the total extent of the yard about twenty acres. New and improved buildings have been projected, and will be erected forthwith. They will include a new joiner's shop 200 ft. in length, by 52 ft. in width, and a new saw mill 80 ft. long by 30 ft. wide. The former, when finished, will doubtless be unique of its kind. It will consist entirely of iron and wood. A lattice-girder crane, with a span of 60 ft., will run parallel with the new saw-mill.

Large Contract by a Bolton Engineering Firm.—The enterprising and well-known thread manufacturers, Messrs. J. and J. Clark, Paisley, are about to build another large factory for manufacturing thread and sewing cotton. Between the two wings of which it will consist there will be the engine house, which will be furnished with compound beam engines of 1200 indicated horse power, being the largest in use for manufacturing purposes in Scotland. The fly-wheel alone will weigh not less than 55 tons, and in order to make a proper foundation for this gigantic machinery, 10,000 cubic feet of stone will be required. Messrs. Musgrove and Sons, Bolton, are the contractors for the engines and boilers.

The Proposed Traction Engine for use between Hamilton and Glasgow.—The Hamilton traders are making progress in their endeavours to establish a traction engine or road steamer for carrying goods traffic between Hamilton and Glasgow. The Road Trustees have given a favourable decision, and so also have the Glasgow Police Board, and some of the promoters of the movement recently left for the Wolverhampton Show and trial of engines, with a commission to buy on order one of the best quality, with the view to its immediate use.

A BRIDGE FOR THE HOOGHLY.—Mr. Leslie, C.E., has prepared plans for a bridge across the Hooghly. One feature in the plans is that the bridge would rest on pontoons which would be very narrow, but unusually deep.

PROGRESS OF MONTREAL.—A census just taken is expected to show a population of 160,000 persons in Montreal. Ten years since the population of the town did not exceed 90,000. Manufactures and commerce have been making great strides in Montreal during the last ten years. Rails have just been laid between Princess-street and the harbour.

RAILWAYS IN THE ARGENTINE REPUBLIC.—The extension to the Salado of the Great Southern Railway of Buenos Ayres has been opened for traffic. The branch is expected to prove a valuable feeder to the main line. The Lobos branch of the Western Railway belonging to the Argentine Government was opened for traffic May 25.

GOODS WAGON FOR THE VILLA MARIA & RIO CUARTO RAILWAY.

CONSTRUCTED BY MESSRS. FOX, WALKER, AND CO., ENGINEERS, BRIDGEWATER.

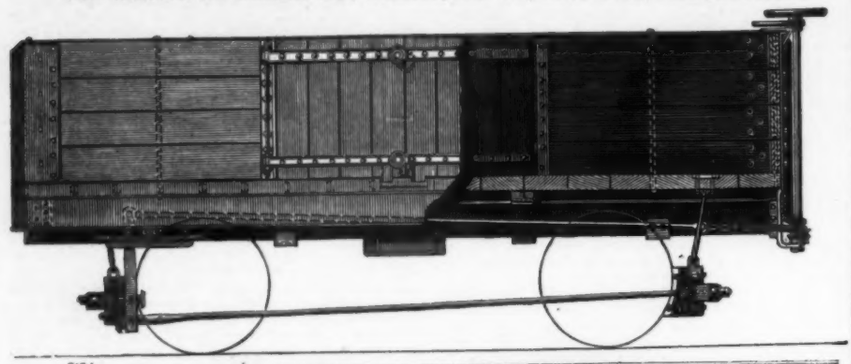


FIG 1.

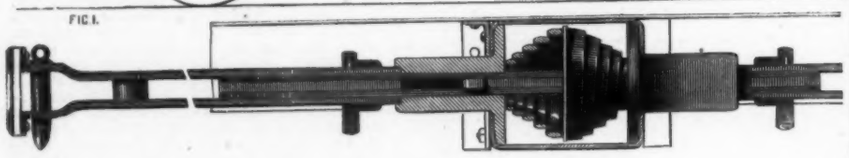
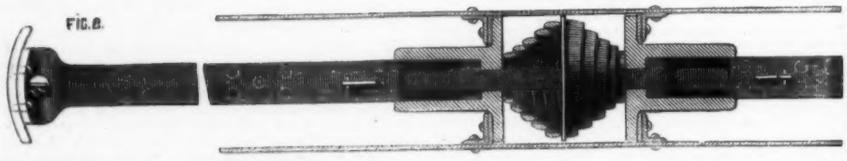


FIG 2.



We illustrate, above, one of a class of 8-ton open goods wagons recently sent out to the Villa Maria and Rio Cuarto Railway in the Argentine Republic. These wagons, together with 5-ton wagons of similar construction, were made by Messrs. Fox, Walker, and Co., at the Bridgewater Works, Bridgewater, from the designs of M. C. F. de Kierzkowski, Westminster. The gauge of the Villa Maria and Rio Cuarto line is 5 ft. 6 in., and the conditions specified by the Government in regard to the rolling stock were that it should be constructed of the four-wheeled English type, but to work with the American bogie stock of the adjoining Central Argentine Railway. The approval of the designs, and the superintendence of the manufacture were intrusted to Mr. Edward Woods, engineer to the Argentine Government.

Both the wagons we illustrate, and those for carrying 5 tons, are 16 ft. long by 9 ft. wide, outside dimensions. The 8-ton wagons have sides and ends 3 ft. high, with folding doors, and the 5-ton wagons have sides and ends 1 ft. 6 in. high, with falling flaps. In all other respects the details of the two wagons are identical. The bodies and floors are made of the best Georgia pitch pine, grooved and tongued with hoop iron. The under frames are wholly of wrought iron, the sole bars being formed of H irons, 8 in. by 4 in. by $\frac{3}{8}$ in., and the headstocks of L irons, 8 in. by 4 in. by $\frac{3}{8}$ in. The bearing of the under frame is arranged in view of the central buffer and draw system, which had to be adapted to work in with the American stock referred to above.

The combined buffer and draw gear used is that patented by M. Kierzkowski, and forms the chief novel feature in the wagons. The general principle of this draw-gear, which was recently noticed by us in our account of the Conversazione at the Institution of Civil Engineers, is that the buffing and drawing strains are received and transmitted through the medium of longitudinal bars, which slide in guides fixed to the under frame. A pair of volute springs placed centrally form the cushion, on which the shocks and strains are received, and the above-mentioned bars are so connected with the springs and with each other, that they buff and draw against each other with the said spring intervening, thus forming an extensible buffer and draw-bar. It will also be seen, on referring to the detail views, that the central springs and their holders, when at rest, fill up the space between the stops, which connect them to the under frame of the wagon, and consequently, when the springs are compressed, either from buffing or drawing, a certain amount of space will be created between the stops and the spring holders, and the wagon will then be free to slip on the buffer and draw bars to the extent of this space, like a bead on a string. It is mainly in this peculiarity that the present buffer and draw-gear differs from some already in use. M. Kierskowski and Messrs. Fox, Walker, and Co., maintain that this slip shields the wagon from the drawing and crunching-up strains, which form so important an element of destruction in rolling stock in a more efficient way than any through buffer and draw bar yet devised.

The wagon is, as it were, unlocked from its buffer and draw bar whenever any strain occurs, and it consequently feels none but the shocks necessary for its own individual progression and stoppage.

The extensibility of the through draw bar, combined with the slip referred to above, secures another advantage of considerable moment in the case of goods trains. It causes the wagons to start consecutively instead of simultaneously, thereby securing the same facility for starting a heavy goods train as by the usual and dangerous system of slack couplings.

Another noteworthy part of these wagons is the brake shown in the high-sided wagon drawing. The brake blocks, which are made of elm, lined with segments of soft cast iron, are fixed to oak cross bars, suspended from the wagon frame in such wise that when free they hang away from the wheels. To one of these cross bars is fixed a pin carrying a lever, which is placed in an oblique position to gain the requisite proportion between its arms. The short arm of the lever is connected by means of a $\frac{3}{4}$ in. rod to the opposite cross bar, and the long arm is connected also by a $\frac{3}{4}$ in. rod to a chain, which is wound round a cast-iron drum carried on a vertical spindle attached to the end of the wagon. The effect of turning the handle of this spindle is to shorten the chain, and thus draw the two cross beams together. The brakes are thus applied with uniform force to the four wheels simultaneously. This kind of brake, which has been made to some extent in America, is found to be very efficient and serviceable.

The axle-boxes, which are intended for oil, are of the simplest character, being cast in one piece. A cast-iron bolster is inserted between the brass and the top of the axle-box. To replace the brass it is only necessary to ease the wagon of its bearings when the bolster can be removed through the trap in front of the axle-boxes, the brass can then also be taken out in the same way. A leather shield fitting tight round the axle protects the journal from dust on the inside. The wheels are 2 ft. 10 in. diameter, and of the description known as "Kirtley's spoke," the boss and skeleton being wholly of wrought iron, the tyres are of best mild Bessemer steel shrunk into place and secured with bolts tapped into them. The other parts of the wagons will be readily understood from the drawing, being of the usual type.

LONDON INTERNATIONAL EXHIBITION OF 1871.—The band of the "Garde républicaine," sent by the French Government to perform for a few days in the International Exhibition, reached London on Tuesday evening. Early on Wednesday they gave an "aubade" at the French Commissioner's residence in Onslow-square. In the afternoon the band played in the garden of the French Court, and subsequently in the Royal Albert Hall, meeting everywhere with great and deserved success.

THE GOVERNMENT AND INVENTORS.—The committee of the Society of Arts appointed to examine the relations between Government and inventors have come to the conclusion that reasonable grounds exist for dissatisfaction as to the treatment which the latter have received. The committee have examined many witnesses, and they passed a resolution to the effect that "the present system of dealing with inventors is unmethodical and unsatisfactory, and the one obvious defect of the present system is the want of a suitable record of the invention submitted, and of the proceedings taken therein." The committee think that a report upon each invention should be presented by suitable persons, independent of the public department using it and of the inventor.—*Globe.*

THE INSTITUTION OF CIVIL ENGINEERS.

THE Council of the Institution of Civil Engineers have awarded the following premiums for papers read at the meetings during the session just concluded:

1. A Telford medal and a Telford premium, in books, to Bernhard Samuelson, M.P., M. Inst. C.E., for his "Description of two Blast Furnaces erected in 1870, at Newport, near Middlesbrough."
2. A Watt medal and a Telford premium, in books, to Jules Gaudard, C.E., Lausanne, for his paper on "The Theory and Details of Construction of Metal and Timber Arches." (Has previously received a Telford medal.)
3. A Telford medal and a Telford premium, in books, to Alexander Beazeley, M. Inst. C.E., for his paper on "Phonic Coast Fog Signals."
4. A Telford medal and a Telford premium, in books, to Thomas Dawson Ridley, Assoc. Inst. C.E., for his "Description of the Cofferdams used in the Execution of No. 2 Contract of the Thames Embankment."
5. A Telford medal and a Telford premium, in books, to James Price, M. Inst. C.E., for his paper on "The Testing of Rails, with description of a Machine for the purpose."
6. A Telford premium, in books, to Walter Raleigh Browne, Assoc. Inst. C.E., for his paper, on "The Strength of Lock Gates."
7. A Telford premium, in books, to Sir Francis Charles Knowles, Bart., M.A., F.R.S., for his paper on "The Archimedean Screw Propeller, or Helix of Maximum Work."
8. A Telford premium, in books, to Hamilton Ela Towle, of New York, for his "Account of the Basin for the Balance Dock, and of the Marine Railways in connexion therewith, at the Austrian Naval Station of Pola, on the Adriatic."
9. A Telford premium, in books, to George Banks Rennie, M. Inst. C.E., for his "Account of Floating Docks, and more especially of those at Cartagena and at Ferrol."
10. A Telford premium, in books, to Arthur Jacob, B.A., Assoc. Inst. C.E., for his paper on "The Disposal of Town Sewage."
11. The Manby premium, in books, to Wilfrid Airy, B.A., Assoc. Inst. C.E., for his paper on "The Archimedean Screw for Raising Water."

The Council have likewise awarded the following prizes to students of the Institution:

1. A Miller prize to Frederick Harry Mort, Stud. Inst. C.E., for his paper on Prussian Railways; their Construction, Cost, and Financial Results."
2. A Miller prize to George Gatton Melhuish Hardingham, Stud. Inst. C.E., for his paper on "Practical Aëronautics."
3. A Miller prize to Arthur Turnour Atchison, Stud. Inst. C.E., for his paper on "The Theory of Energy, and its application in the form of Heat to the Steam Engine."
4. A Miller prize to Henry Francis Joel, Stud. Inst. C.E., for his paper on "Bricks and Brickwork."
5. A Miller prize to William Tweedie, Stud. Inst. C.E., and a Miller prize to Francis Wilton, Stud. Inst. C.E., for their paper on "The Calculation and Designing of Girders."
6. A Miller prize to Henry Oliver Smith, Stud. Inst. C.E., for his paper on "Materials employed in Sewer Construction."
7. A Miller prize to Killingworth William Hedges, Stud. Inst. C.E., for his "Description of the Pumping Machinery employed at the Works of the Amsterdam Canal."

LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—The thirty-seventh half-yearly meeting of members of this institution was held on Saturday the 1st inst., at the City Terminus Hotel. Mr. J. Newton, Assoc. Inst. C.E., president, occupied the chair and the large assembly room was completely filled. After the reading and reception of members of the preceding sitting, Mr. George Potter, foreman of boiler makers for Messrs. Steward and Company, Millwall, was unanimously elected an ordinary member. Messrs. Saxton, Frankham, Waycott, and Saxon were also proposed in the same category. The chairman next invited the auditors—Messrs. Welch and Philips—to produce the balance sheet of the society for the past half-year, together with their report thereupon. From the first named document it appeared that the receipts for that period amounted to 161*l.* 1s. 5d., and the disbursements to 116*l.* 1s. 6d. The general fund for conducting the current business of the association was shown to be 507*l.* 4s. 11d. The superannuation department exhibited 1125*l.* 17s. 1d. to its credit, and the widows' and orphans' fund 19*l.* 16s. The grand total of moneys invested or in the hands of the treasurer for all purposes, therefore, is at this moment 1652*l.* 17s. 1d. The number of ordinary members of the institution is 120 and of honorary members 80, or in all 200. The balance-sheet and reports were after some slight discussion unanimously accepted by the meeting. Messrs. Salmon, Reid, and Coates were then chosen as a junior committee for the ensuing half-year and Mr. Sissons as second auditor for the same period. The chairman afterwards with a few introductory remarks proceeded to read a paper (communicated by Mr. Angus Macpherson) on "What is Steel?" This was of very great interest and exceedingly well written. The character and composition of the material were scientifically and practically elucidated, the modes [of testing its quality by chemical analyses, by aid of the microscope and more by practical agencies were clearly described, and statistics evidently compiled with much care demonstrated the quantity and value of the steel annually produced in Great Britain. Prominence was given to the invaluable discoveries of Bessemer and Mushet, and the use of steel as a material for shipbuilding, &c., duly commented upon. The paper was well received and followed by a spirited and well sustained discussion, in which Messrs. Salmon, Ives, Lax, Coates, White, Nicholson, Gibbon, the chairman, and others took part. Eventually votes of thanks to Mr. Macpherson and the chairman were passed and their acknowledgment by the latter closed the proceedings.

THE EAST RIVER BRIDGE.

Second Annual Report of the Chief Engineer (Colonel Washington A. Roebling) of the New York Bridge Company.

To the Honourable HENRY G. MURPHY, President of the New York Bridge Company.

SIR,—I have the honour to present the following report of operations on the East River Bridge during the past year:

At the date of the last annual report, made June 5, 1870, the first foundation-stone had been laid on the Brooklyn caisson, which was still afloat at the time, rising and falling with the tide. During the year that has elapsed the foundation of the Brooklyn tower has been successfully completed, notwithstanding numerous drawbacks, the caisson being sunk to a depth of 45 ft. below high water. The tower masonry is now being carried up, and has reached a height of 25 ft. above high tide.

The first material was brought up from the caisson by dredgers July 5. By December 18 it rested upon 72 brick piers, which had been built for its reception within the air chamber. The filling up of the air chamber required two months and a half, being finally closed March the 11th, nearly one month of which time was consumed in repairing the damages to the caisson caused by the fire of December 2, 1870.

The laying of masonry practically ceased in the middle of December, a rigorous winter forbidding its resumption until the middle of March.

Inasmuch as the Brooklyn caisson is by far the largest structure of its kind ever sunk, although not the deepest, and since the bulk of the material encountered was next to solid rock in difficulty of removal, it may be of general as well as professional interest to enter into a more detailed account of the operations.

Excavation of Material.

While the caisson was still rising and falling with the tide, the hours of work inside the air chamber were confined to low water. Three courses of masonry were required to weigh it down permanently against the buoyant effect of the inflated air chamber. The force of workmen inside was gradually increased, their principal occupation being the removal of sharp-pointed projecting boulders, which threatened to damage the supporting frames and edges of the caisson, as the latter settled down on them with a crushing force at low water.

Although the preliminary dredging had arrived at an uniform level of 18 ft. below high water, it was found that there were enough boulders overlooked to reduce this level to 16½ ft. Several weeks were spent in removing them and levelling off the ground under the shoes to the 18 ft. level before the excavating machinery was ready to operate. In the pits under the water-shafts were several large boulders below the water level, upon which the lower edge of the water-shafts rested. These were a source of considerable anxiety until removed by the tedious operation of clipping them to pieces with long steel bars.

The material now became sufficiently exposed to enable us to arrive at the conclusion that it was of a very formidable nature, and could only be removed by slow, tedious, and persistent efforts. This had indeed been the expectation, from our previous experience in the dredging and blasting under water. But the work being under water, and, therefore, out of sight, did not impress us so much at the time, as now, when we were face to face with it.

Nature of Material.

In the two middle chambers of the caisson the ground was composed of trap boulders, large and small, packed together so closely as to touch, the space between being filled by a natural concrete, composed of decomposed fragments of green serpentine rock. The boulders were coated with this natural cement, which adhered so strongly as to defy the action of steel wedges. A steel pointed pick had no effect whatever. It was only by using a steel pointed crowbar, and driving it in the crevices with heavy sledges that any of this material could be piled up and removed. In chambers Nos. 1 and 2 adjoining the Fulton Ferry slips the boulders were equally as large and as numerous, but the cementing material was clay and gravel, not so hard as the serpentine concrete. In chambers Nos. 5 and 6, however, this hard ridge rapidly fell away, giving place to several feet of mud, underlaid by a stratum of unctuous blue-clay, and continuing soft in the north corner of No. 6 chamber for a depth of 40 ft., as had been indicated by previous soundings.

It was evident, therefore, in order to have an uniform foundation over the entire area of the caisson, it would be necessary to go down fully 40 ft., and this depth was extended to 45 ft., so as to have the timber entirely below the iron bed.

The area of the caisson, 17,000 square feet, is so large that no uniform stratum over the whole surface would be likely to be found anywhere within this drift formation at any moderate depth below the water level. No better foundation could have been wished for than that found in chambers Nos. 3 and 4, provided it had extended all over.

Nine-tenths of the boulders were trap, transported hither during the drift period from the palisades of the Hudson. Owing to their hardness they had resisted the wear of the time the longest. They occurred of all sizes, from 1 cubic foot up to 250. Boulders of quartz and gneiss rock occurred more rarely. Two large boulders of red sandstone were also found. The softer varieties of rocks had all been worn down to pebbles. A collection made of the various specimens encountered during the descent of the caisson presents a complete series of the rocks found for a hundred miles to the north and north-east of Brooklyn.

Lowering the Caisson.

The adoption of a regular system for lowering the caisson uniformly was a matter of much experiment at the beginning. No amount of pressure could force the bearing surfaces of it through the ground without crushing the cast iron shoe at the cutting edge, or smashing the bearing frames. A few days' experience demonstrated that fact. On the contrary, it became a matter of primary importance to dislodge all boulders in advance before the shoe or the frames came to a bearing upon them.

All this work had to be done under water, because there was usually along the shoe a trench filled with water communicating with the water outside, and this trench was connected with cross-trenches under the frames, which in time supplied the large pools around the water shafts.

The finding of these boulders in advance was a laborious, disagreeable, never-ending task. Its performance fell entirely upon the engineering staff in the caisson, Colonel Paine and Mr. Collingwood, and the principal foremen, Messrs. Young and Clark. The perimeter of the shoe or cutting edge measures about 540 ft.; adding to this the five frames of 102 ft. each gives a total length of 1050 lineal feet of bearing surface, every inch of which had to be carefully probed under water twice a day with a steel sounding bar, and the proper conclusions drawn as to the best means of moving the rocks, hard-pan, and other material found. Each shifting gang of labourers had to be informed anew whenever their turn of work came on. Being under water, this, beside, became a matter of memory, and not of mere eyesight. Moreover, a settling of the caisson of 6 in. or a foot would bring to light an entirely fresh crop of boulders in new positions, and very often half without and half within the caisson.

The shoe being of necessity unsupported, it was left for the frames to support so much of the weight of the caisson as was not balanced by the air pressure.

The first attempt in the operation of lowering was to leave small pillars of earth under the frames, about 3 ft. square, and from 6 ft. to 8 ft. apart, the intervening earth being taken away, and forming part of the trench. These pillars were to be then uniformly undermined, and the caisson lowered in that manner. It was soon found that the pillars usually concealed the head of a large boulder, which required their premature removal. Again, the water would wash them down, and still oftener the labourers in adjacent chambers not working in unison would undermine them and destroy their effect.

The plan next adopted worked very well, and was pursued to the end. It consisted in supporting the frames every 8 ft. on two wooden blocks, 12 in. square and 2 ft. long, one above the other, with four stout oak wedges interposed between the blocks and bottom of the frame. A continuous trench, 2 ft. deep and 4 ft. wide, was thus maintained under the frames, giving ample working room for the removal of boulders. Whenever the shoe had been cleared out for 6 in. in advance, these wedges were then loosened with sledge hammers, one by one, and frame by frame, until the caisson slowly settled. Then either new blocks were put in of a smaller size alongside, or, as was usually the case, they were allowed to crush. Very often a sudden descent of the caisson would crush half the bearing blocks, until brought up by the shoe. The operation was analogous to the splitting out of blocks and wedges during the launch of a ship.

The bottoms of the frames were originally 2 ft. wide. This width was found too great to allow of the easy removal of rocks from underneath. They were, therefore, cut down to a width of 1 ft. The lower ends of the frames were likewise cut loose from the side of the caisson, to allow more easy access to the point of the junction. This reduction of bearing surface added materially to the risk in case of accident.

Removal of Boulders and Earth.

Boulders occurring inside of a chamber were usually left undisturbed until the caisson had sunk sufficiently to enable us to attack them above the water level. They were then split into manageable blocks by plug and feather.

Boulders under the frames presented more difficulty. The ground in which they were embedded was cut away with steel bars as much as possible; they were then drilled under water, and a lewis inserted. The appliances for pulling them out of their beds were various. Those first in use consisted of double sets of block and tackle, aided by winches and crowbars, with a gang of 30 or 40 men hauling at the ropes. All this force was frequently found ineffective. The strain required being usually from two to three times the weight of the stone. The cause of this lay in the air pressure, which amounted not only to the 15 lb. of atmospheric pressure, but the caisson pressure in addition, the whole being effective by reason of the water-tight clay in which the stone was imbedded. As soon as the boulder was loosened in its bed to a slight extent, it soon followed. These hauling arrangements were replaced after a time by three of Dudgeon's hydraulic pulling jacks, two of 10 tons and one of 15 tons capacity. This proved to be a very effective instrument. They were usually attached to heavy screw bolts let into the roof of the caisson and formed part of a chain leading to the stone. Many boulders, however, resisted the united efforts of all three jacks.

The removal of the hard earth could be effected at the beginning only by the use of steel pointed crowbars driven in with sledge hammers. Under water the blow of a pick has but little effect. The long handled, round pointed shovel answered best for lifting the material out of the water into wheelbarrows.

After the caisson had been lowered about 2 ft. it became possible to build dams around the trenches under the frames and bail out the water. This enabled us to see the work at hand, and materially lightened the labour attending it. These dams were shifted from trench to trench, care being taken always to leave an open trench leading to the water shaft.

The removal of the water from the trenches was accomplished partly by hand-bailing, then by air syphon pumps and steam syphon pumps, and finally by compressed air itself, throwing it entirely outside of the caisson through pipes introduced through the timber and masonry.

To work the air syphon a complete system of 1¼ in. pipes, was placed in the caisson with suitable connexions. Through these pipes air was introduced under a pressure of 60 lb., one of the main air pumps being set apart for that purpose. The pump was constructed on the principle of a Giffard injector, and as the duty required was simply to lift the water from 3 ft. to 4 ft. it was expected to work well, but it never did. Steam was then introduced in place of extra compressed air through the same pipes. This answered the purpose admirably, draining the trenches in a short time. It afforded an ocular demonstration of the operation of a Giffard injector, since the caisson simply corresponds to the interior of a huge boiler, and steam, under the same tension as the caisson pressure, produced the desired result. One circumstance, however, led to its early abandonment. When the pump had worked a few minutes, the temperature would rise to 100°, driving the men from that particular chamber. Recourse was then had to a simple flexible suction hose, communicating with a pipe leading out of the caisson. The end of this hose was held in the water, so that about three-fourths of it was submerged. The compressed air rushing through the remainder of the opening kept the whole column of water in motion at a rapid rate. This mode is, of course, attended with a slight loss of compressed air, but it proved far simpler to raise the water 40 ft. out of the caisson than 4 ft. inside of the caisson. Soft mud and fine sand passed out readily with the water.

Boulders under the Edge.

The occurrence of large boulders under the shoe proved to be the most serious obstacle to a rapid sinking of the caisson. As long as the water from without still had free communication with the air chamber, they had to be attacked under water, the most tedious part of the operation being the removal of the earth in which they were imbedded. When the stones extended more than 2 ft. or 3 ft. outside of the caisson no attempt was made to haul them in, but they were slowly chipped to pieces, until enough had been removed to enable the edge of the caisson to clear them.

As soon as the dredgers were at work, the excavated material was dumped around the outside of the caisson, with a view of stopping the ready passage of water under the shoe. This was effected after a time. Then, by building a clay dam around the boulder on the inside, and filling up the adjoining space with bags, it became possible to dig a comparatively dry pit underneath, into which it was tumbled, provided it was not too large.

Several boulders occurred which delayed all settling for three or four days at a time. In order to gain time a special force of some thirty men was then organised, who worked only at boulders from 11 o'clock at night until 6 a.m., when the regular gangs came to work.

It may truly be said that the result of the first month's work was not very encouraging. We had a material to deal with which is difficult to remove, even under favourable circumstances, on top of the ground. The rate of descent had not averaged 6 in. a week, and the boulders were increasing instead of diminishing in numbers. To look forward to a rate of lowering of even 1 ft. per week seemed hopeless.

The work inside was rendered still more disagreeable by the frequent "blows," caused by the rushing out of the compressed air under the shoe. This would continue for several minutes, until a returning wave of inflowing water from some other part of the caisson would check it, leaving, however, a foot of water all over the ground for some time, until the air pressure drove it out, and the occurrence repeated itself. The trenches were usually flooded thereby and had to be pumped or bailed out incessantly. These flows were caused by change of the water level outside, due partly to passing steamboats, but principally to constant changes in the tide. The thick fog which accompanied them was always an indication that they were transpiring in some part of the caisson.

On the other hand we were daily gaining in experience. The workmen became more accustomed to the novel situation and more practised in the particular kind of work to be done, and the heaping up of a bank of earth around the outside led us to hope that when the caisson had sunk a few feet lower the conditions of air pressure and the general regimen of the caisson would become more equable, and, what was of more importance, the free access of water from without would probably be materially curtailed. These expectations were more than realised. In a short time water became as scarce as it had been plentiful before.

Blasting.

When the caisson had arrived at a depth of 25 ft. below the water level, the boulders became so large and numerous as to compel us at last to resort to blasting. The idea of using powder had been entertained all along, yet our imaginary fears, supported by plausible reasoning, had prevented the attempt thus far. It was supposed that the effect of the explosion would produce a violent concussion in that dense atmosphere, rupturing the eardrums of the men. Again, the effect upon the doors and valves of the air locks might be such as to endanger their safety.

The principal apprehensions were, however, in the direction of the water shafts. Here were two columns of water 7 ft. square, and ultimately 45 ft. high, held in a critical balance by the pressure inside, the margin of safety being an immersion of less than 2 ft. on part of the lower edge of the shaft in the pool surrounding it. The sudden explosion might rapidly depress the level of the pool and allow the air to escape underneath, which would be fatal both to the caisson as well as the men inside. Again, as regards blasting under the shoe and partly outside of it, it was feared that the explosion might cause a vent outward, followed by a rush of air.

The result, however, justified none of these apprehensions.

First, a trial was made by firing a pistol with successively heavier charges, then small charges were fired off by a fuse, and soon blasting became an established system. The good effects were at once apparent in the lowering of the caisson from 12 in. to 18 in. per week in place of 6 in.

The first entry into the caisson was made with considerable misgivings, but none of our fears were realised.

The total settling that took place amounted to 2 in. in all. Every block under the frames and posts was absolutely crushed, the ground being too compact to yield; none of the frames, however, were injured or out of line. The brunt of the

blow was, of course, taken by the shoe and sides of the caisson. One sharp boulder in No. 2 chamber had cut the armour-plate, crushed through the shoe casting and buried itself a foot deep into the heavy oak sill, at the same time forcing in the sides some 6 in. In a number of places the sides were forced in to that amount, but in no instance were they forced outward. The marvel is that the air tightness was not impaired in the least.

The nine courses of timber forming the sides of the air chamber were permanently compressed to the extent of 2 in., as was shown by protruding boltheads and the shearing off of a number of diagonal bolts. The lower sills of the frames were also torn where they came upon boulders.

The weight of the caisson at the time was 17,675 tons. The air blew out so suddenly that this weight must have acted with considerable impact in falling through the space of 10 in. The bearing surface at the time was as follows: The four edges of the caisson, 550 ft. long and 7 in. wide, amounting to 322 square feet; the five frames each 100 ft. long and 1 ft. wide, resting on twelve blocks 1 ft. wide, amounting to 60 square feet, and giving a total of 382 square feet to meet the above pressure. This at the rate of 46 tons per square foot.

But more than one-half of the shoe was undermined to a depth of 1 ft. or more, which reduced the practical bearing surface by nearly one-half. At the commencement of the shock there was therefore a pressure of 80 tons per square foot, no allowance being made for impact, which may have doubled this rate. The caisson had settled 10 in. The shoe had buried itself so as to present a width of 12 in., and through the crushing of the blocks the frames were in many places resting bodily on the ground. The settling had, therefore, stopped when a bearing surface of 775 square feet had been reached, giving a pressure of 23 tons per square foot.

As the caisson proceeded in its downward course, the disproportion between the dead weight above and the air pressure from below became greater and greater. For instance, on the 15th of November, the escape of air under the shoe was so strong that no more than 10 lb. of air pressure could be maintained. The over pressure entailed thereby was 12,240 tons. This was received by a bearing surface of 280 square feet, causing a pressure of 44 tons per square foot.

In order to meet this constantly increasing overweight, a large number of additional shores were introduced into the caisson. They rested upon a block and wedges, and supported a cap spiked against the roof. The presence of these shores added considerably to the labour of lowering the caisson, and diminished the available working space otherwise. They gave, however, a positive assurance against any possible crushing weight from above, and could, moreover, be easily removed when a boulder was taken out, which could not be done with the permanent frames.

The downward movement of the caisson was usually so impulsive that the blocks under the posts were allowed to crush and were subsequently dug out. In fact, their crushing was the only indication we had that any portion of the caisson was bearing particularly hard. The noise made by splitting of blocks and posts was rather ominous, and inclined to make the reflecting mind nervous in view of the impending mass of 30,000 tons overhead. No satisfactory estimate could be made of side friction. There must have been some, but of a very irregular character. At times an outside boulder would apparently hold one end of the caisson until a bolt head or part of the timber gave way. The batter on the outside being 1 ft. in 10 ft. was calculated to relieve the caisson from side friction. The workmen, however, never dug out far enough behind the shoe, thus causing great friction for several feet up the sides, and pressing in the sides to as much as 9 in. in some places. The side friction probably never exceeded 3000 tons. The larger the base of a caisson the smaller is the percentage of side friction available to counteract downward pressure, whereas, in a narrow caisson penetrating an uniform sand, it is often sufficient to counterbalance the whole weight.

A Curious Incident.

A few words will suffice to explain the mode of operating the supply shaft. It consists of a tube 45 ft. long and 21 in. diameter inside, with a door at the bottom opening into the air chamber, and a long door on the top, through which the material is thrown in. When the upper door is open, the lower one is held shut by the air pressure, assisted by two iron clamps worked by levers. As soon as a certain quantity of material has been thrown in, the upper door is pulled up, and the compressed air being thus allowed to enter, firmly closes it. When the shaft is filled with compressed air, a signal is given to the attendant below, who removes the lugs, the door falls, and the contents of the shaft drop into the air chamber. The operation is very simple and rapid, and perfectly safe with the most ordinary precaution. Two of these shafts were found ample to furnish all the material required for filling up the caisson. They had worked well for five weeks, but danger always steps in when, through use and familiarity, the attendants become careless and reckless. It had occurred at times that a charge of building stones or brick would become jammed, and only part of a load would drop out. To ascertain this fact a string with a weight was let down from above each time, so as to avoid putting in a double charge. Upon this occasion a charge had jammed, the men dumped in another, without measuring the depth either before or after, and then gave the signal to the man below, without shutting the upper door, or letting in the compressed air. The second charge happened to loosen the first, and the two together overcame the pressure against the lower door, when the lugs were turned. As soon as this happened the air commenced to rush out of the caisson with a great noise, carrying up stone and gravel with it. The men above ran away, leaving those below to their fate. Any one with the least presence of mind could have closed the upper door by simply pulling at the rope.

I happened to be in the caisson at the time. The noise was so deafening that no other noise could be heard. The setting free of watery vapour from the rarefying air produced a dark, impenetrable cloud of mist, and extinguished the lights. No man knew where he was going, all ran against pillars or posts, or fell over each other in the darkness. The water rose to our knees, and we supposed, of course, that the river had broken in. It was afterwards ascertained that this was due to the sudden discharge of the columns of water contained in the water shafts. I was in a remote part of the caisson at the time; half a minute elapsed before I realised what was occurring, and had groped my way to the supply shaft, where the air was blowing out. Here I joined several firemen in scraping away the heaps of gravel and large stones lying under the shaft, which prevented the lower door from being closed. The size of this heap proved the fact of the double charge. From two to three minutes elapsed before we succeeded in closing the lower doors. Of course everything was all over then, and the pressure, which had run down from seventeen to four pounds, was fully restored in the course of fifteen minutes. A clear and pure atmosphere accompanied it. The effect upon the human system and the ears was slight, no more than is experienced in passing out of the airlock.

Under the head of "Fires," Mr. Roebling details the history of the fire of December 2.

Lighting of Caisson.

The subject of illuminating a caisson in a satisfactory manner is rather a difficult problem to solve. A powerful light is of prime necessity, to overcome the want of all reflecting surfaces, to penetrate the thick mists usually occupying such places, and to illuminate every foot of a soil which was anything but uniform in character. The burning of candles is attended with an intolerable amount of smoke, resulting from a rapid but incomplete combustion. This nuisance was overcome somewhat by reducing the size of the wick and of the candle, and by mixing alum with the tallow, and also steeping the wick in vinegar. The inhaling of so much floating carbon is very injurious to the lungs, as the lampblack remains in there for weeks and months. Nevertheless candles have to be used more or less for all special work requiring illumination close by. Lamps are of little account, since they smoke more than candles, and the oil is dangerous in case of fire.

Fortunately, the existence of an establishment in New York for the production of oxygen gas in large quantities and at moderate prices made the introduction of calcium lights quite feasible.

Organisation of Working Force.

Each shift of men worked in the caisson eight hours at a time, the first watch from 6 a.m. to 3 p.m., including one hour for breakfast; the next watch from 3 p.m. to 11 p.m., including one hour for supper; then a special night gang from 11 p.m to 6 a.m.

The majority of the men took their meals along and remained down the full eight hours without any injury.

The two day shifts alternated from week to week. They consisted of 1 general foreman, 6 assistant foremen, (one for each chamber), and 112 labourers. The special night gang was composed of 1 general foreman, with 2 assistants and 40 labourers, making a total force below of 3 general foremen, 14 assistants, and 264 labourers. This force was constantly recruited from time to time, and an inspection of the time books show that 2500 different men have worked in the caisson.

On deck there were double shifts of engineers and firemen to run the excavating engines, and engines for running the dirt cars, also two gangs for attending to the dumping of the latter. In addition there were the engineers for the air compressors, and stone hoist engine, blacksmiths, machinists, and gas men, one gang to remove the boulders brought up by the buckets, a carpenter's force of 25 men, and 30 men for setting masonry. The total daily force amounted in all to 360 men.

Dock.

During the winter months the substantial dock resting on top of the caisson, on the river side, was completed, filled in, and provided with a track, turn-tables, and unloading derrick.

New York Caisson.

The plans for this caisson were perfected in the summer of 1870. A contract for its construction was made in October with Messrs. Webb and Bell, the builders of the first caisson, the ironwork being done by John Roach and Sons, of the Morgan Iron Works. It was built at the foot of Sixth-street, New York, the old yard in Greenpoint having been abandoned for shipbuilding purposes.

A rather severe winter, with delays on part of the iron work, prolonged the completion of it to the 8th of May, on which day it was launched with the same success attending the first launch. It is now lying in the Atlantic Basin, where seven additional courses of timber and concrete are being put on preparatory to its removal to its permanent site. In its construction this caisson is in its general features a duplicate of the Brooklyn caisson. It is built of yellow pine timber, the air chamber being lined with a thin skin of boiler plate on the inside. The roof consists of five courses of yellow pine sticks 12 in. square; the inclined sides surrounding the air chamber are also of yellow pine, and are 9½ ft. high on top, and taper to a rounded cutting edge of cast iron 8 in. wide, and enveloped by an armour or boiler plate.

The timbers in all the courses are scarfed and bolted together with screw bolts and drift bolts. About 180 tons of bolts were used in the fastenings. The dimensions of the base are 172 ft. by 162 ft., covering an area of 17,544 square feet. Its length is 4 ft. greater than the Brooklyn caisson.

The air chamber has a height of 9 ft. 6 in., and is divided into six rooms by five main frames. The rooms vary from 25 to 30 ft. in width, by 102 ft. long, and are subdivided by lighter secondary frames running through the middle. In addition there are two heavy cross frames extending through the whole length of the caisson. The amount of bearing surface is 18 per cent. of the whole base, and will be increased to 25 per cent. of the whole base, by reason of the sloping sides, in case the caisson should sink into the soil 2 ft.

The main frames are of solid timber, and 4 ft. wide, composed of two central ties of horizontal timber and two outer rows of posts. They are secured to the roof by long through bolts, extending through the lower three courses of the roof, and are heavily braced sideways. The ends of the frames are secured to the sides of the air chamber by knees and iron straps. Each frame is pierced by doorways of ample size to afford communication between the adjoining chambers.

The secondary frames are open work, composed of posts and sills, and can be strengthened if the necessity should arise. An iron skin lines the inside of the air chamber. The iron is light boiler plate, of No. 6 gauge. A light iron was purposely selected, in order to overcome to some extent, by its buckling, the difficulty arising from the expansion and contraction of so large a surface rigidly bolted to an unyielded mass of timber. In addition, a series of expansion joints of angle iron were put in transversely to aid in taking up the contraction. No trouble has been experienced from this source since the launch. All spaces between the skin and the timber have been filled with cement.

Floor.

The New York caisson was launched with a temporary floor extending over the whole base. This was made necessary by reason of the shallow water in front of the launching ways. The floor will remain until the caisson is permanently grounded on the river bed, and will help materially in maintaining a level position of the same.

The air chamber will not be inflated until the caisson has touched bottom, and enough masonry has been laid to prevent its rising at high tide and from the pressure of the compressed air. This floor then comes into play to distribute uneven pressures until access is had to the air chamber and the work of excavating has commenced. Respectfully submitted,

W. A. ROEBLING, Chief Engineer.

Table of Quantities.	*New York Caisson.*
Length over all	102 ft.
Breadth	102 ft.
Height	14 ft. 6 in.
Area of base	17,554 square feet
Quantity of timber	118,000 cubic feet
Weight of bolts	180 tons
Weight of ironwork	200 tons
Launching weight of caisson ...	3250 tons

COPELAND'S WASHING BOWL.

THE subjoined woodcut represents in section a wash-hand bowl, a brush tray, and a soap dish made in one slab. The novelty consists in having an overhanging margin surround-

ing each of these receptacles, to prevent their contents being thrown out when used in ships or other travelling conveyances. The design is registered by Messrs. Copeland, 160, New Bond-street, W.

AMERICAN RIVERS.—A series of water gauges are to be established by the United States War Department upon the Mississippi and its tributaries so that information may be obtained for the protection against floods of the adjacent lands.

PATENT LAW REFORM.—At a meeting of London patent agents, held on the 4th instant, to consider the proposed changes in the patent laws, George Haseltine, M.A., in the chair, the following resolutions were adopted: 1. That the chief defects of the patent laws have arisen from a want of appreciation of the natural rights of inventors to the sole use of their inventions, an unreserved recognition of which rights must pervade every equitable patent system, and the true aim of patent legislation is to harmonise these individual rights with the material interests of the State. 2. That the grant of patents to mere "first importers" is an injustice to inventors, an injury to society as it induces the "pirating" of inventions, and the reason for these grants no longer existing, legislation should confine the issue of patents to actual inventors and their representatives. 3. That, in view of the benefits inventors confer on the public, and the expenses incident to the completion and introduction of new inventions, a patent for fourteen years is an inadequate compensation, and we deem it expedient to grant patents for a term of twenty-one years without the privilege of extension. 4. That the patent laws impose penalties upon inventors in the form of excessive fees, which justice and public policy demand should be reduced to the amount requisite to defray the expenses of an efficient administration of a simple patent system, and fees of ten pounds for the entire term—now one hundred and seventy-five pounds—would yield more than sufficient for the purpose. 5. That the defects of the present practice should be remedied by the adoption of equitable "regulations," and the introduction of the system of granting patents, at the risk of the applicants, without any official supervision of the specification or preliminary investigation of the merits of the invention. 6. That the rights of patentees should be determined by a competent tribunal, excluding all technical objections to the validity of the patent, and we deem it expedient to dispense with jurors and "scientific experts" in patent suits. 7. That these resolutions, signed by the chairman, be forwarded to the Parliamentary Select Committee on Letters Patent, and such other publicity be given them as he may deem conducive to the success of a liberal measure of patent legislation.

THE "WATERSTAAT" OF HOLLAND.

No. I.

IT cannot fail to be a matter of regret that, in a country whose inhabitants, after having won it from the sea, have been able to retain their possession for more than two thousand years, and where hydraulic engineering must have so long been known and practised, no complete annals of the rise, progress, and development of the science have been kept; and that not until towards the end of the last century, general and united efforts were made to stay the aggressions of the common foe, and render the conquest secure. Such, however, is the case of Holland; and to this state of things the independent right of sovereignty possessed by the separate provinces contributed, for although after each great inundation all were unanimous in repairing the devastation caused, yet as soon as the danger had passed, party feeling regained its sway, and the general weal had to suffer.

The interests of the so-called Waterstaat were confided to several boards, known as hoogheemraad enwater schoppen polderbestmen, &c., all of which possessed extensive executive power, to which even police regulations were subject. The need of a central Government and of united action was universally felt; on such depended the national safety, the maintenance of dykes and other works. Therefore, in May, 1754, the Grand Pensionary, in the name of the Princess of Orange, appointed M. Lulofs, professor at the University of Leyden, Inspector-General of the Waterstaat. In 1768, he begged for an assistant in this work, and obtained the appointment of Christian Brunings, the son of a German clergyman, to whom, with his sons, had been granted the freedom of the City of Amsterdam.

Brunings was a man of eminent qualities, and without doubt one of the cleverest hydraulic engineers of his time. Sensible of the importance of an improvement in and proper maintenance of the inland rivers, he wrote, "What does it avail us that the sciences and professions prosper, that trade and freedom flourish, nay, that under wise government we enjoy the most delightful peace, if year by year we are threatened with losing the fruit of all this by the unbridled violence of our inland rivers; what is the use of our protecting the land against the attacks of the sea at an immense cost; of our indefatigable zeal in draining lakes and pools, and creating pleasant drives in these places, so long as one single fatal movement, the giving way of a dyke, can plunge us for years, perhaps for ever, in the deepest misery?"

It is not strictly speaking from his appointment that the institution of a general board of the Waterstaat dates. An attempt, without success, was made by the departmental or provincial governments in 1795, who appointed a board of nine members for the affairs of the sea-dykes and sea-walls, with Brunings at its head; and on his advice, a second board was appointed for the northern part of Holland.

In 1796 the National Assembly of the Batavian Republic met at the Hague, by whom, in 1797, a proclamation was issued, in which the principle of unity in the direction of the Waterstaat was admitted; but much was not effected. In 1798 the second National Assembly issued a proclamation by which the direction of the Waterstaat was confided to those in whose hands it then was, only that they should be considered as administrative bodies, and responsible to the Executive Government, who issued an order that the control of the roads, posts, dykes, and waters should be part of the department of Police and Inland Correspondence.

In all these movements, the influence of Brunings was very great. He was consulted on the improvements of the higher rivers, and nearly all the works of hydraulic architecture. Principally in consequence of his indefatigable reasoning it was that the Executive Government of the Batavian Republic on the 24th May, 1798, resolved on a plan for the control of the Waterstaat, by which it was distributed into three departments. 1. For flowing rivers; 2. For sea-dykes and sea walls; 3. For affairs of the interior; and, besides, it was ordered that the members of this board should reside near the works they had to superintend. By this Assembly, also, the citizen Frederick William Conrad was appointed deputy to assist the president of the general Waterstaat, C. Brunings. This was the first regular organisation of the Waterstaat.

Frederick William Conrad, senior, the pupil, friend, and successor of Brunings, was born at Delft, on the 23rd December, 1769, of humble parents. Before the age of ten years he lost both father and mother, and being without fortune, he was bred in the Orphan House of his native town.

In the course of two years, his good conduct, extraordinary abilities, and improvement earned for him a presentation on the foundation of the Lady of Renswond. In 1787, at the age of 17, he was engaged in the hydraulic works at Sluis in Flanders, under the captain of engineers, Barnstad. At the age of 19, appointed to be assistant land surveyor at the river operations in South Holland, he came into immediate connexion with the Inspector-General Brunings. At his own request, he remained a pupil on the foundation, giving account of all his earnings to the governors, till 1794, when he left it, receiving the sum of 5000 florins (416*l.*) which he had saved. Brunings now considered him as his right-hand, his friend, and declared that he could not do without him. This connexion was continued till the 16th May, 1805, when Brunings died suddenly in his arms, at the Hague.

In 1796, Conrad was appointed Deputy Inspector-General of Rhineland with the understanding, that he should not withdraw from the service of the rivers; in 1798, he was appointed to assist Brunings as president of the Board for the superintendence of the sea-dykes and sea-walls of Holland, and the year following to assist him and, in his absence, to supply his place in the superintendence of the sluices and dock works at Hellevort Sluis. In 1803, as Commissioner-Inspector of Amstel and Tunel, he received the thanks of the town council of Haarlem, and obtained the title of Inspector of the Sea Harbours and Channels of the North of Holland. In 1802, his excellent treatise on the Rhineland Slaperdike obtained for him the honourable thanks of the Government of Rhineland. On the 25th of July, 1804, he received the greatest proof of confidence in his eminent attainments, being appointed director of the works on the Rhine at Kotwyk, since on the good execution of the great discharging sluices there, the safety of a large portion of Holland depended. In this also he maintained his fame, as the first hydraulic engineer of his time.

After the death of Brunings, Conrad was appointed Inspector-General of Rhineland, and on the 20th January, 1807, by the King Inspector-General of the Waterstaat of Holland. This employment he held but one year, for he died on the 6th of February, 1808. King Louis held him in high esteem, as he showed by making him one of the first knights of his newly instituted order of merit.

In the year 1794, F. W. Conrad was married to Wilhelmina Broesterhinzen; the fruit of this marriage was three sons, Jan Willem, born 1st October, 1795, at the Hague, Martimius Hendrik on the 25th February, 1798, and Frederik Willem on the 15th February, 1800, these two at Spaardidam. It was the youngest, Frederik Willem, who achieved the highest fame as an hydraulic engineer, and who was also the founder and president of the Royal Institution of Engineers in the Netherlands.

Great was the sympathy shown on all sides to the widow and her three orphans on account of the early death of the elder Conrad. An annuity was accorded her by Rhineland, and King Louis, by decree, ordered that her three sons should be bred up to the Waterstaat, and that they should enter the royal service with a stipend of one florin a day till they could be more suitably provided for, and further, that the widow should reside at the place where the chief offices of the Waterstaat might be located.

In consequence of this arrangement, the brothers were placed under the charge of the Director-General of the Waterstaat, A. Twent. After the incorporation of Holland with France, the Emperor Napoleon I. decreed, that the same allowance should be paid for them till they were able to enter the Ecole Polytechnique, thence to be transferred to that of the Ponts et Chaussées. The political events of 1813 frustrated this plan. After the establishment of the schools for the artillery and engineers at Delft, W. Conrad and F. H. Fynje were, on the 9th of July, 1814, in consequence of a royal decree entered as cadets of the Waterstaat. Towards the end of the year 1816, after having visited the principal works in progress in North and South Holland, at the Helder, in Zeeland and Flanders, Conrad was proposed as Aspirant Ingénieur to the Waterstaat, by Major-General Voet, director of the school aforesaid, and appointed to that employment in 1817. The great works of that time soon afforded ample opportunity for the development of his talents, and henceforth his history is intimately connected with that of the Waterstaat. Towards the close of 1825, he was promoted to the rank of engineer of the second class. Amid his numerous occupations he found leisure enough to answer the questions "when dangerous damage from slips or other causes appears in the dykes of our chief rivers; what are the best and fittest means for arresting its progress and preventing its consequences?" proposed by the Haarlem Society of Sciences, and rewarded with their gold medal, and the premium of 150 florins. The rank of engineer of the first class was conferred on him in 1834. In 1838, his advice was required in some difficulties connected with the construction of the Holland Railway. He obtained permission from the Government to afford it, was associated with that work till its completion as director-engineer, and in this proved himself eminently a technical and practical engineer, by the manner in which he overcame the many and great difficulties the work presented; the bridges which he designed, and to which he gave the name of Kraanbruggen (swing bridges) deserve particular notice. In 1842 he was presented with the Telford medal by the Institution of Civil Engineers, for his description of the canal at Kotwyk, which was translated into English by Mr. Charles Manby, and read before the Institution on 21st June, 1842. Elected a Member of that Institution, he conceived and carried out the plan of establishing such an institution of engineers in the Netherlands, hence on the 14th March, 1848, the Royal Institution of Engineers held its first sitting, and F. W. Conrad was elected its president. Besides the Telford medal, Conrad obtained from the Institution of Civil Engineers the Walker premium, for his description of the railway from Amsterdam to Rotterdam, read on the 16th March, 1847. In 1851, nominated by Prince Albert as member of the jury of the Exhibition of that year, he received three medals, one as a member of the jury, one as an exhibitor, and one for his services after the opening of the palace at Sydenham; besides, his plan of an exhibition building was honourably mentioned.

He was mainly instrumental in introducing electric telegraphy into the Netherlands. In 1854, he obtained the rank of chief engineer of the first class, and then wished for rest; but the grand plan of the Suez Canal called up his energies, he was chosen President of the International Committee on his first journey to Suez in the winter of 1855-1856. He undertook a second journey in the winter of 1856-1857, and ascended the Nile to beyond the first cataract. His last journey to Egypt was undertaken that he might be present at the opening of the Canal. On his return he died at Munich, on the 1st of February, 1869.

(To be continued.)

SOUTH AMERICAN STEAM NAVIGATION.—A line of steamers is said to be in contemplation between New Orleans and Central and South American ports. The object of the enterprise is to secure the coffee trade.

THE UNITED STATES NAVY.—The United States steamer Wachusett is about to be docked in the Norfolk navy yard, and will have a new propeller put in. The United States steamer Hartford has been undergoing repairs at New York.

ENGINES FOR THE INTERCOLONIAL RAILWAY.—The Canadian Engine and Machinery Company has turned out the first of fifteen locomotives which it had undertaken to supply for the Intercolonial Railway. The locomotive is built for a broader gauge, but can be converted for a 4 ft. 8½ in gauge at a trifling cost.

COAL AT BOSTON (U.S.).—The receipts of coal at Boston to June 17 this year were as follows:—Anthracite, 100,969 tons; Cumberland, 79,696 tons; and foreign, 12,593 tons. In the corresponding period of 1870, the corresponding receipts were: Anthracite, 124,083 tons; Cumberland, 42,975 tons; and foreign, 19,102 tons.

AMERICAN TELEGRAPHY.—The net profits of the Western Union Telegraph Company for the year ending June 1, 1871, were 2,547,854 dols., as compared with 2,227,045 dols. in 1870-1. In 1866, the company had 97,000 miles of wire; in 1870, 120,000 miles. In 1867, the number of messages transmitted by the company was about 4,000,000; in 1870, the total had risen to 8,000,000, exclusive of press messages. The construction of new lines cost in 1867 415,000 dols; in 1868, 355,000 dols.; in 1869, 673,000 dols; and in 1870, 400,000 dols. The capital stock of the company is 35,000,000 dols., and it has a bonded debt of 4,000,000 dols.

BAUSCHINGER'S INDICATOR EXPERIMENTS ON LOCOMOTIVES.

(*Continued from page 2.*)

2. *On the form of the Indicator Curves.*

IN order that the indicator curves obtained from an engine may convey a correct idea of the action of the steam, it is necessary to construct, in the first place, the valve motion diagrams, either geometrically or from a model, due regard being paid to the deviations arising from the obliquity of the connecting rod. We do not consider it indispensable that the valve motion diagrams prepared by Herr Bauschinger should be reproduced here, but we shall, in the course of our examination of the indicator curves, refer to distribution cards obtained from those diagrams, by means of which the corresponding openings of the steam ports can easily be ascertained. We at present illustrate, in Figs. 1 to 4, the valves of the four engines with the shifting link motion, and in Figs. 5 to 8 those of the other engines which are fitted with Meyer's double valve motion, drawn to a scale of 3 in. to the foot. We also show figures giving the stroke of the eccentrics with the lead, and the proportion of the eccentric rods and expansion links belonging to the former engines. To complete the description of other parts affecting the action of the steam, Herr Bauschinger gives in his work a Table containing the areas of the regulator openings, of the steam and exhaust pipes, of the ports, and of the blast pipe orifices, and the capacities of the clearance spaces, these including the contents of the pipes connecting the indicator with the cylinder ends. These data are contained in the annexed Table (III.)

Professor Bauschinger's collection of indicator diagrams is a very extensive one, the average number of double curves taken of each engine being not less than 61. Of this number the work under notice contains from 8 to 10 diagrams per engine, taken at various speeds, positions of the regulator, blast pipe and reversing lever (or expansion valves respectively). For the purpose of criticism, however, we think it to be sufficient to reproduce only two series of curves appertaining to the two different systems of valve motions, namely, the single valve and the double valve motions, reserving for cases of special interest the illustration of additional diagrams.

TABLE III.

Class of Engine.	Regulator opening in per cent. of cylinder area.	Main steam pipe area in per cent. of cylinder area.	Branch steam pipe area in per cent. of cylinder area.	Steam port area in per cent. of cylinder area.	Clearance space in per cent. of cylinder capacity.	Exhaust pipe area in per cent. of cylinder area.	Main exhaust pipe area in per cent. of cylinder area.	Blast orifice area in per cent. of cylinder area (open.)	Blast orifice area in per cent. of cylinder area (shut.)
A	6.6	9.6	7.1	8.2	6.1	18.0	20.0	9.4	3.0
B	6.6	9.6	7.1	8.2	6.1	18.0	20.0	9.4	3.0
C	7.6	10.8	6.0	9.1	6.0	17.5	20.4	13.0	7.8
D	7.5	10.8	6.1	8.0	6.1	18.0	30.6	11.8	3.4
E	8.0	7.6	6.4	7.7	6.1	17.5	22.6	9.2	2.8
F	9.0	12.0	10.8	6.7	6.2	9.0	11.4	21.0	7.6
G	9.0	12.0	6.3	7.5	5.8	9.0	16.0	12.2	4.4
H	9.0	11.6	7.6	6.0	8.8	8.5	16.0	7.2	2.6

Table of reference gives for each pair of curves the circumstances under which they were taken, namely:

1. The speed the engine was travelling, expressed in revolutions of the driving wheel per minute, as obtained with the stroke counter, and reduced, also, to feet per second of average piston speed.

2. The regulator opening. It should be observed, under this heading, that the opening of one-half was sufficient to admit the maximum quantity of steam, and that this amount should therefore be considered equivalent to "full open."

3. The blast pipe opening, which can be modified within the limits indicated in Table III.

4. The boiler pressure (BP.) being the average indication of the steam gauge for the minute during which the curve was taken.

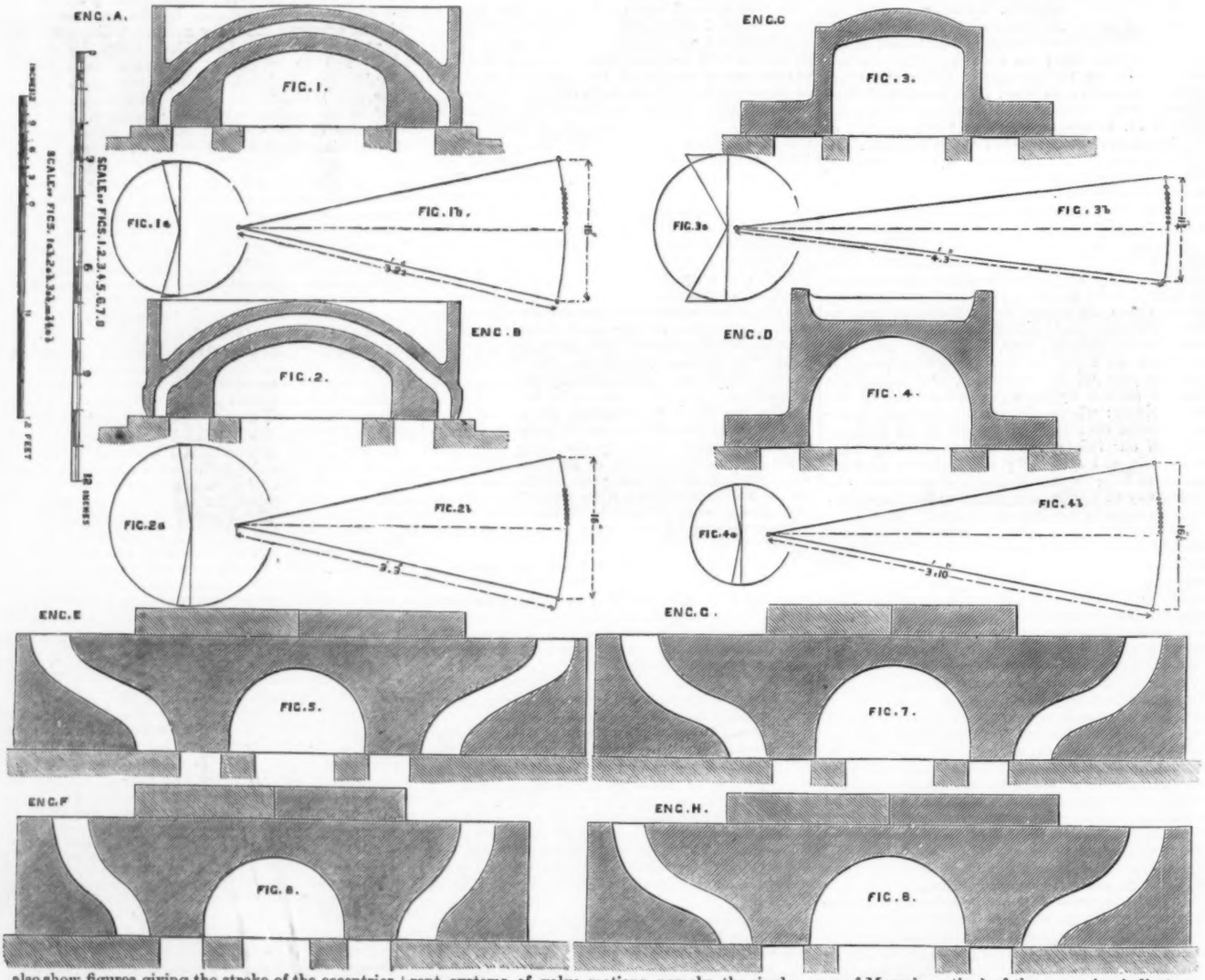
5. The maximum cylinder pressure for both cylinder ends expressed, both in pounds per square inch and in percentage of boiler pressure.

6. The average effective cylinder pressure (PM.) obtained by circumscribing the curves with Amsler's planimeter.

The position of the reversing lever, or (as in the case of Meyer's motion) of the expansion indicator, is also given for each series of diagrams; in addition to this, the degree of admission, as shown by the valve-motion diagram, is also inscribed besides the number of "notch;" and differing as it does for the two cylinder ends—on account of the obliquity of the connecting rod—this value is given for both ends, hind and front. In the curves themselves, the leading points of the steam distribution, as, beginning of admission, expansion, release, and compression, are distinctly marked.

The curves, appertaining to each degree of expansion, are in all cases preceded by an explanatory diagram, which—having been reduced from the full size valve-motion diagram—shows very clearly the action of the slide valve.

(*To be continued.*)



* We are compelled by the demands upon our space to defer until next week the publication of these various diagrams, together with the detailed references to them.

STONE BREAKING MACHINE AT THE WOLVERHAMPTON SHOW.

CONSTRUCTED BY MR. H. R. MARSDEN, ENGINEER, LEEDS.

(*For Description, see Page* 24.)

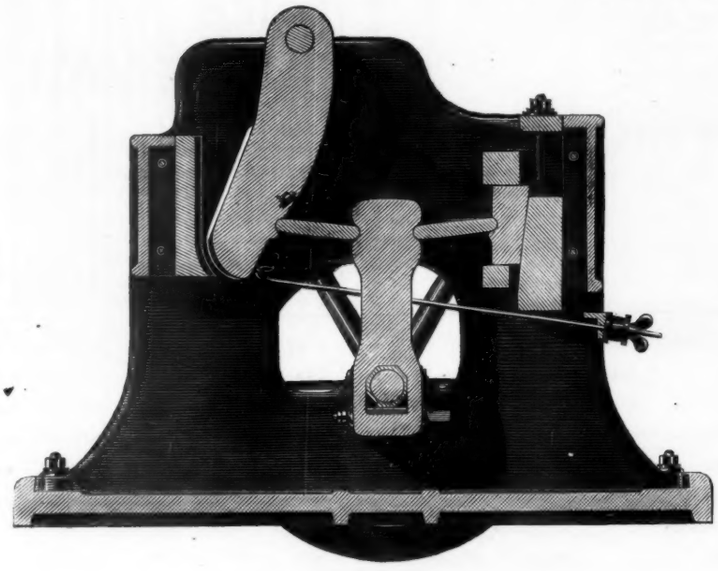
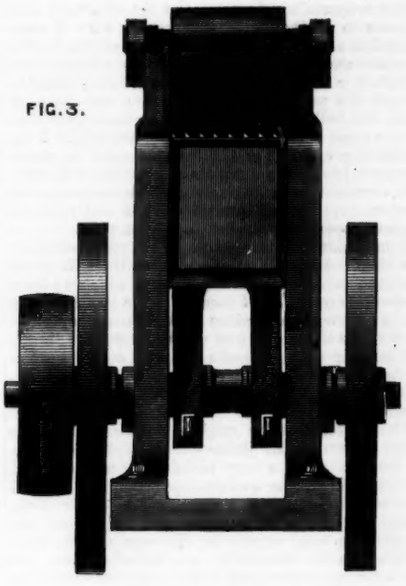


FIG. 3.



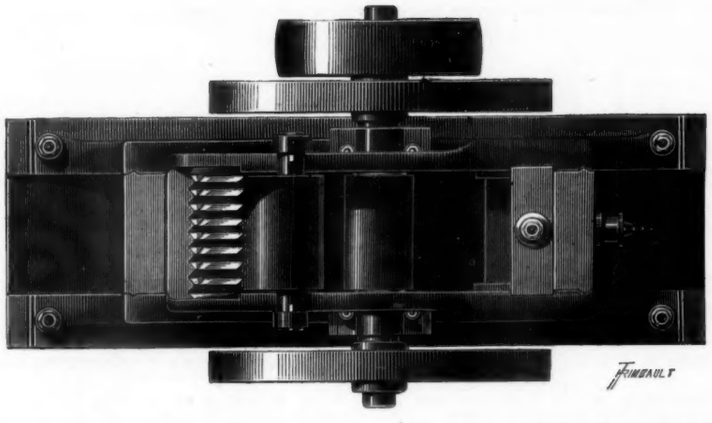


FIG. 4.

THE WOLVERHAMPTON SHOW.

OUR first duty this week in writing about the Wolverhampton Show, is the disagreeable one of correcting an error which appeared in our last number. This error occurs in the twenty-seventh column of the Table on page 5 of our last issue, and it consists in the fact that the figures in that column, instead of being what the heading represents them to be, namely, the numbers of pounds of water evaporated from the temperature of the feed per square foot of heating surface *per hour*, are really the quantities evaporated per square foot of heating surface during the entire runs. The figures in the next column, which are derived from those in the twenty-seventh, are also proportionately wrong. The error, although almost self-evident, is a very annoying one, and our only excuse for having allowed it to pass without detection, consists in the very brief interval which elapsed between the conclusion of the trials and the time at which the Tables had to be prepared ready for going to press. As the best way of correcting the error, we have, in the Table on the next page, reproduced some of the columns from that which appeared last week, those in which the mistakes occurred (columns G and H) having been corrected; while we have also availed ourselves of the greater time placed at our disposal to work out three new columns (columns I, J, and K), containing data which we believe will be useful. In columns I and J, the evaporation of the various boilers per square foot of heating surface, per hour, has been reduced to that which would have been obtained if the feed had in all cases been supplied at the temperature of 55°, while in column K is given the quantity of coal consumed per square foot of heating surface per hour. A comparison of the figures in this last mentioned column with those in that marked I, enables a very good idea to be formed of the average efficiency of the heating surfaces of the various boilers. If we assume as we may do without introducing any error of practical importance—that the quantity of heat developed per pound of coal burnt was the same in all cases, then the figures in column K will represent the proportionate average amount of heat presented for absorption to each square foot of heating surface per hour in the different boilers. Thus in the case of Messrs. Aveling and Porter's 10-horse engine each square foot of heating surface had to deal, per hour, with the heat resulting from the combustion of 0.61 lb. of coal, while on the other hand each square foot of surface in Messrs. Ransomes, Sims, and Head's boiler, had to deal in the same time with the heat resulting from the combustion of 0.91 lb.

On the other hand, the figures in column I may be taken as representing the comparative amounts of heat actually absorbed per hour by a square foot of heating surface in the different cases, while a comparison of these figures with those in column K give, as we have said, an idea of the relative efficiency of the absorbing surfaces under the respective conditions of working. Thus comparing the performance of Messrs. Aveling and Porter's 10-horse engine with that of Messrs. Ransomes, Sims, and Head's we find that each square foot of surface of the latter boiler had about 1½ times as much heat presented to it per hour, as was the case with the former, while the heat actually absorbed was about 1½ times as great. This comparison shows that the superior evaporative efficiency of Messrs. Aveling and Porter's boiler may have been partly due to its being less hardly worked than Messrs. Ransome's, and not solely to the more advantageous arrangement of its heating surface. We say *may* have been, because it is by no means proved by the experiments that this was actually the case, while on the other hand there is good ground for believing that the rate of evaporation in Messrs. Aveling and Porter's 10-horse boiler might have been considerably increased without materially impairing its evaporative efficiency. Some evidence on this point is afforded by the relative performances of Messrs. Aveling and Porter's two 6-horse engines. These engines have boilers of identical construction and dimensions, and the results of the trials prove—as shown by the Table—that the boiler which was most hardly worked gave a slightly less evaporative efficiency than the other; but this latter was superior to the 10-horse boiler although it evaporated a considerably greater quantity of water per square foot of heating surface per hour. It is much to be regretted that time was not available for carrying out a series of trials to test the efficiency of the various boilers at different rates of evaporation, as the results which would have been ascertained would have possessed much scientific interest and would have been of great practical value. It is very generally supposed that the less the amount of coal consumed per square foot of heating surface per hour in any given boiler,

the greater will be the evaporative efficiency per pound of coal consumed; but this is only correct within certain limits, and what those limits are is at present far from being accurately defined. It is, however, certain that an increase in the quantity of coal consumed per square foot of heating surface per hour is not always accompanied by a decrease in the evaporative efficiency, and the reason for this appears to be that with an increased rate of consumption a more intense combustion of the fuel is obtained and a less amount of air is required per pound of coal consumed, the effect being that although the products of combustion may pass off from the boiler at a higher temperature, yet their weight is so reduced that the amount of heat which they carry off is less than it would be under what are frequently considered to be more favourable circumstances. The relative performances of Messrs. Aveling and Porter's 6-horse and 10-horse engines appear to constitute a case in point.

Continuing now our record of the proceedings of the Royal Agricultural Society at their Wolverhampton meeting, the next matter of which we have to speak in our present number is the trip made by the various traction engines from Wolverhampton to Stafford on the morning of yesterday week. In our last number we published a telegram containing the leading results obtained on that occasion, and we now give in the annexed Table the various data in greater detail.

The various traction engines enumerated in this Table performed the journey from Wolverhampton to Stafford all in a very satisfactory manner, and —considering some awkward portions of the road over railway bridges and sharp curves—with little delay. No mishap of any kind occurred during this remarkable trip, except in the case of the train attached to Mr. Burrell's "pot boiler" engine. In this instance, a considerable stoppage was caused by one of the wagon wheels coming off, and accordingly this engine appeared last at the "winning post." The length of the stoppages of the other engines, or, in other words, the difference between gross time and net time as given in our Table, was generally caused by taking in water, which operation occupied about one hour in each case over the whole course. Referring to the Table, the quickest run was made by Messrs. Ransomes, Sims, and Head's engine with india-rubber tyres, using, however, 3.75 lb. of coals per ton of load per mile, while Messrs. Aveling and Porter's 10-horse engine consumed but 2.5 lb. per ton per mile.

In connexion with these trials, we should, also, mention the run performed by the steam omnibus "Chenab." As already stated in our last week's telegram, the "Chenab" made the trip from Wolverhampton to Stafford in 2 hours 30 minutes, or, at the rate of 6.4 miles per hour net time; the load drawn, however, was a comparatively light one, consisting of the omnibus and a small party of passengers, making in all about 4 tons of gross load, exclusive of engine, weighing 13.5 tons.

Yesterday week, also, was a kind of show-day at Stafford, the various exhibitors of steam-ploughing tackle showing their machinery at work on the portion of Mr. Darlington's farm, which had been hired by the Royal Agricultural Society for that purpose. The farm, in the occupation of Mr. Darlington, is nearly three miles from Stafford, and the land—a tough clay, very tenacious when wet—had been chosen for the purpose of enabling the various tackles to be tested under different conditions to those which existed at Barnhurst, where the ground was of a very light character. Part of the land on which the tackles were tried near Stafford, was very hilly, with some exceedingly awkward hollows, and this was particularly the case in the plot on which Messrs. John Fowler and Co.'s 20-horse double engine set displayed its capabilities. The results of the first trials of this set at Stafford were recorded by us on page 8 of our last number, and we need merely add here that its subsequent performance with other implements was equally satisfactory, as was also that of Messrs. Fowler's other tackles. The Ravensthorpe Engineering Company also performed well with their tackle constructed on Mésars. Fisken's system, the engine being placed by the side of a supply of water some 200 yards or so from the plot which was being cultivated, and the fast-running rope being led over the intervening ground to drive the windlass. This tackle has done some very good work during the trials at Wolverhampton, and we are glad to find that the judges have granted an award to it. Messrs. J. Fowler,

TABLE SHOWING THE PERFORMANCE OF THE BOILERS OF THE TRACTION ENGINES TESTED AT WOLVERHAMPTON.

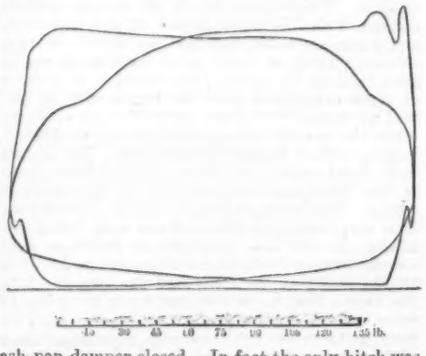
A	B	C	D	E	F	G	H	I	J	K	L
Reference number.	Makers' Names.	Class of Boiler.	Temperature of feed.	Quantity of water evaporated from temperature of feed per pound of coal consumed.	Equivalent quantity of water which the boiler would have been capable of evaporating from feed at 55° per pound of coal consumed.	Quantity of water evaporated *from temperature of feed* per square foot of heating surface per hour.	Number of square feet of heating surface to evaporate 1 cubic foot of water per hour *from the temperature of the feed.*	Equivalent quantity of water which the boiler would have been capable of evaporating per square foot of surface per hour from a temperature of 55°.	Number of square feet of surface which would have been required to evaporate 1 cubic foot of water per hour from a temperature of 55°.	Pounds of coal consumed per square foot of heating surface per hour.	Pounds of coal consumed per square foot of firegrate per hour.
			deg.	lb.	lb.	lb.	sq. ft.	lb.	sq. ft.	lb.	lb.
1	Aveling and Porter's (10-horse)	Locomotive ...	170	8.488	7.649	5.19	12.04	4.68	13.36	0.61	17.27
2	" " " (6-horse)	"	140	8.414	7.79	6.36	9.84	5.89	10.61	0.75	19.8
3	" " " (6-horse)	"	170	8.313	7.49	7.09	8.8	6.39	9.78	0.85	24.53
4	Ransomes, Sims, and Head ...	Thomson's pot boiler	cold	6.72	6.72	6.18	10.11	6.18	10.11	0.91	24.0
5	Charles Burrell	Locomotive ...	165	8.165	7.39	5.35	11.68	4.84	12.91	0.65	15.58
6	J. and F. Howard	Howard's patent ...	cold	6.09	6.09	5.08	12.3	5.08	12.3	0.82	28.77
7	Tuxford and Sons	Locomotive ...	110	7.285	6.94						
8	Charles Burrell	Thomson's pot boiler	cold	5.95	5.95	7.9	7.91	7.9	7.91	1.33	27.8

TABLE SHOWING PERFORMANCE OF TRACTION ENGINES ON ROAD FROM WOLVERHAMPTON TO STAFFORD.
(Length of course 16 miles.)

Reference number.	Makers' Names.	Nominal horse power.	Weight of engine in working order.	Load taken.				Coals consumed.			Time.	
				Description of train.	Weight.	Total weight, exclusive of engine.	Total weight, including engine.	Total quantity used during trip.	Per ton of load per mile, exclusive of engine.	Per ton of load per mile, inclusive of engine.	Total time on road.	Net time, exclusive of stoppages.
			ts. ct. qr.		ts. ct. qr.	ts. ct. qr.	ts. ct. qr.	ct. qr. lb.	lb.	lb.	h. m.	h. m.
4	Ransomes, Sims, and Head ...	8	10 8 3	1 portable engine 1 thrashing machine 1 loaded wagon	4 10 0 3 9 2 4 0 2	12 0 0	22 8 3	6 1 20	3.75	1.82	4 28	3 35
3	Aveling and Porter	6	5 4 2	1 portable engine 1 loaded wagon	5 0 0 4 0 0	9 0 0	14 4 2	3 2 0	2.73	1.72	5 17	4 15
1	Aveling and Porter	10	11 4 3	1 portable engine 1 thrashing machine 1 loaded wagon	3 19 0 2 17 0 8 4 0	15 0 0	26 4 3	5 1 17	2.5	1.44	5 30	4 25
5	Charles Burrell ... (locomotive boiler)	8	7 15 0	1 portable engine 1 loaded wagon	4 0 0 8 0 0	12 0 0	19 15 0	4 3 0	2.8	1.68	6 5	5 10
8	Charles Burrell ... (pot boiler)	8	8 18 2	1 loaded wagon 1 loaded wagon	4 0 2 7 19 2	12 0 0	20 18 2	8 2 0	5.	2.85	6 49	5 10

Messrs. Howard, Messrs. Barrow and Stewart, and Messrs. Amies and Barford also showed sets of "roundabout" tackle at work, while Messrs. Fowler and Co., in addition, exhibited at work—besides the 20-horse double engine set already mentioned —a 12-horse double engine set, and their clip-drum and double-drum engines and the tackle belonging to them. We have not given any tabulated record of the results obtained yesterday week, simply because there were no definite results to tabulate. The day was in fact a regular show day, the various tackles being worked to show their powers, and those of the implements, to the general public, and not for the purpose of obtaining definite scientific data.

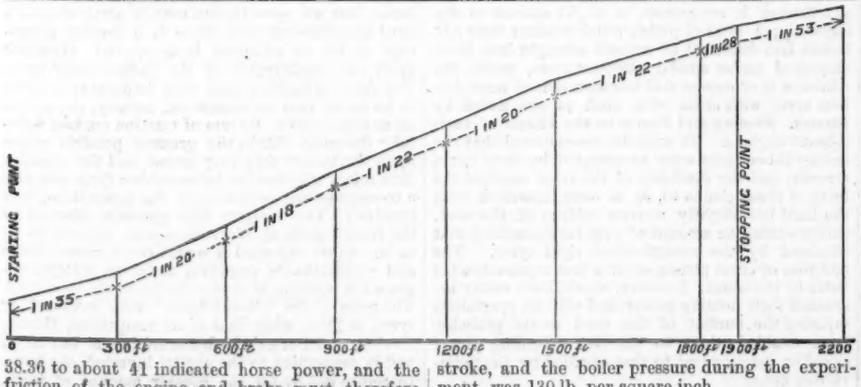
Dismissing for the present the steam-ploughing tackle, we must pass on to notice a very interesting experiment made last Friday morning at the show-yard at Wolverhampton on one of Messrs. Aveling and Porter's 6-horse traction engines. This experiment was made to investigate the working of the engine under a heavy load, and for this purpose the engine was coupled to the friction brake, and the latter was, we are informed, loaded so that when the engine was running at 160 revolutions per minute, it was developing 36.7 actual horse power. The result of the trial was that the engine actually run at 160 revolutions per minute, the boiler making an ample supply of steam with the



ash-pan damper closed. In fact the only hitch was that the suction pipe of the pump was too small to allow of the proper supply of feed water being maintained, and thus the experiments could not be continued long enough to obtain really definite data regarding the expenditure of fuel and water with the engine working under such exceptional conditions. Indicator diagrams, taken during the trial while the engine was running at 160 revolutions per minute, show the development of from but

LIST OF AWARDS OF PRIZES, &c., AT THE WOLVERHAMPTON SHOW.

Number.	CLASS.	Exhibitors to whom awards were made.	Awards.	Exhibits for which the prizes were awarded.	Price.
					£ s.
1	For the best combination of machinery for the cultivation of the soil by steam power.	J. Fowler and Co.	1st prize 100*l.*	Pair of 12-horse engines and tackle for working on the double engine system.	1360 0
		" "	2nd " 50*l.*	Pair of 20-horse engines and tackle for working on the double engine system.	1975 0
2	For the best combination of machinery for the cultivation of the soil by steam power, the weight of the engine not to exceed 10 tons.	" "	1st " 50*l.*	12-horse engine fitted with clip drum, travelling windlass, and balance cultivator, &c.	799 0
		Ransomes, Sims, and Head	2nd " 25*l.*	Tackle constructed on Fisken's system, and worked by "flying rope."	690 0
3	For the best combination of machinery for the cultivation of the soil by an ordinary agricultural engine, either self-propelling or portable.	J. Fowler and Co.	1st " 50*l.*	"Roundabout" tackle with combined 4-furrow plough, digger, and cultivator, and combined drill, and two sets of harrows.	375 0
		J. and F. Howard	2nd " 25*l.*	"Roundabout" tackle with double-acting cultivator, or with combined 4-furrow plough, digger, drill, harrows, &c.	416 10
Lord Vernon's prize	For the best combination of machinery for the cultivation of the soil by steam power, the cost of which shall not exceed 700*l.* The engine to be locomotive, and adapted for threshing and other farm purposes.	J. Fowler and Co.	Cup, value 100*l.*	8-horse engine with two drums, travelling windlass, and combined 4-furrow plough, digger, and cultivator.	698 0
4	For the best windlass, detached.	Tuxford and Sons	20*l.*	Windlass driven by expanding friction clutches, and fitted with automatic brakes.	75 0
	For the best snatch block, or substitute therefor.	Amies, Barford, and Co.	10*l.*	Campain's self-moving disc anchor.	35 0
6	For the best plough suitable for steam cultivation.	J. Fowler and Co.	25*l.*	Four-furrow plough.	80 0
7	For the best subsoiler suitable for steam cultivation.	" "	20*l.*	Subsoiler.	100 0
8	For the best digger suitable for steam cultivation.	" "	25*l.*	Four-furrow digger.	80 0
9	For the best cultivator suitable for steam cultivation.	" "	25*l.*	Five or seven-tined cultivator.	60 0
10	For the best skim plough or scarifier suitable for steam cultivation.	" "	20*l.*	Eleven-tined cultivator.	85 0
11	For the best roller suitable for steam cultivation.	Amies and Barford	10*l.*	Press-wheel roller or clod-crusher with new steerage.	35 0
12	For the best harrow suitable for steam cultivation.	J. and F. Howard	10*l.*	Steam harrow.	22 10
13	For the best drill suitable for steam cultivation.	J. and F. Howard	10*l.*	Steam drills.	80 0
		J. Coultas	10*l.*		75 0
					45 0
14	For the best root or stone-extractor suitable for steam cultivation.	J. Fowler and Co.	10*l.*	Root or stone-extractor.	
15	For the best combination of any of the above implements not qualified to compete in Classes 1, 2, or 3	No award on account of insufficient merit			
16	For the best implements or parts of tackle suitable for steam cultivation of any description not qualified to compete in the preceding classes.	J. and F. Howard	10*l.*	Combined subsoiler and ridger.	21 0
		J. Fowler and Co.	10*l.*	Harrow frame with ridging bodies.	85 0
17	For the best agricultural locomotive engine applicable to the ordinary requirements of farming.	Aveling and Porter	50*l.*	10-horse agricultural locomotive.	330 0
"	" " "	Aveling and Porter	Silver medal	6-horse engine with W. B. Adams's elastic tyres.	340 0
"	" " "	Ransomes, Sims, and Head	"	8-horse "farm steamer" with Thomson's india-rubber tyres.	750 0
"	" " "	Aveling and Porter	highly commended	6-horse agricultural locomotive.	300 0
"	" " "	Charles Burrell	commended	8-horse agricultural locomotive.	370 0
18	For the best wagon for agricultural purposes, to be drawn by an agricultural locomotive engine.	Aveling and Porter	20*l.*	Low-sided trolley.	40 0
		J. Fowler and Co.	Silver medal	Ditching plough.	100 0
		Mellard's Trent Foundry	"	Ploughs with rotating disc mould boards.	
	Hop Machinery:				
1	For the best machine for the cultivation of hop gardens to supersede manual labour.	Not awarded	20*l.*		
2	For the best machine for washing the hop plant to remove the aphis blight.	Coleman and Morton	10*l.*	Hop-syringing engine.	9 0
3	For the best hop presser.	Weeks and Son	10*l.*	Hop-pressing machinery.	25 0
4	For any other implement or implements used in the cultivation or management of hops.	Weeks and Son	10*l.*	Hop-sulphurating machine.	12 12



38.36 to about 41 indicated horse power, and the friction of the engine and brake must therefore have been very moderate. We annex one of the indicator diagrams to which we have just referred, this diagram, which is drawn in our engraving to the scale annexed, showing a mean effective pressure of 100.65 lb. per square inch, equivalent, at a speed of 160 revolutions, to 38.36 indicated horse power. The engine, it may be remembered, has a single cylinder, 7¼ in. in diameter, with 10 in. stroke, and the boiler pressure during the experiment, was 130 lb. per square inch.

We have next to record as a kind of supplement to our description of the traction engine trials over the course at Barnhurst Farm, a series of experiments, certainly not less interesting, which took place last Saturday over a portion of hard macadamised public road at Tettenhall, near Wolverhampton. After the very pronounced *fiasco* of Thomson's india-rubber tyres at Barnhurst, it was to be anticipated that the advocates of this system of construction should be desirous of testing the alleged merits of india-rubber tyre engines on a less treacherous foundation than was afforded by the condition of the ground during the preceding trials. Accordingly, a move was made from the farm to the road by selecting, for a further contest of india-rubber *versus* common tyres, a portion of the steep but hard-bedded road near Tettenhall Toll-bar. The character of the course will be sufficiently understood from the section which we publish on the present page, and which shows a total rise of 93.2 ft. in 1900 ft., or a mean gradient of 1 in 20.39 for this distance, while, in plan, the road course winds itself along in a curve of about 20 chains radius. The trials were under the supervision of Mr. J. F. Bramwell and Mr. James Easton, who so ably conducted all the former experiments with the competing agricultural locomotives, and the trials were also watched, among others, with special interest, by Lord Vernon, president of the Royal Agricultural Society.

The first trip was made by Messrs. Ransomes, Sims, and Head's engine "Sutherland," fitted with Thomson's india-rubber tyres. The total gross load hauled was 26 tons 4 cwt.—exclusive of the engine weight—consisting of three loaded wagons and one portable engine. The weight of the engine itself was 10 tons 10 cwt., making the total weight of the train 36 tons 14 cwt. As during the runs at Barnhurst, the engine was driven by Mr. Head, who managed, without any difficulty and without a single stoppage, to accomplish the distance of 1900 ft. in 10½ minutes. Encouraged by this successful run, a second start was subsequently arranged with an additional load of 11 tons 4 cwt. 3 qr., composed of Messrs. Aveling's 10-horse engine, which happened to be on the ground, making, consequently, a gross load hauled of 37 tons 8 cwt. 3 qr., while the total weight of the train was increased to 47 tons 84 cwt. 3 qr. Under these conditions all went on well over the first section of the course of 1 in 35, the boiler pressure being at 150 lb., but getting on the next gradient of 1 in 20, the engine was unable to continue its trip with this load. After the portable engine, weighing 5 tons, had been detached from the train, the "Sutherland" proceeded again during a few minutes, when continued slipping, with steam at 157 lb., brought her finally to a stop.

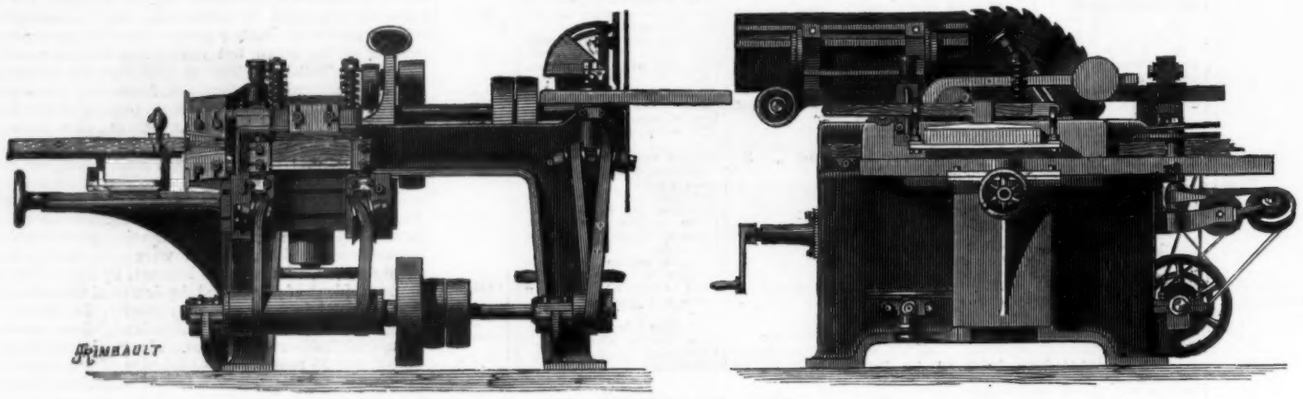
The next proceeding in connexion with these trials was now to test the tractive power of Messrs. Ransomes, Sims, and Head's engine, with tyres of the ordinary kind. To this end the engine was again run to the toll bar at the bottom of the course, and a pair of 5 ft. cast-iron wheels, with smooth surfaces, but 19 in. wide, were substituted for the original Thomson wheels.

At this time it was suggested that Messrs. Aveling and Porter's 10-horse locomotive should try its hauling power on the hard road, and accordingly a train of three loaded wagons and a portable engine was speedily arranged. Mr. Aveling himself—who, by-the-bye, is always there when he is wanted—soon made his appearance on the spot, and, of course, cheerfully accepting the challenge, a start was at once made with the same train weight as was first taken up by Mr. Head, viz., 26 tons 4 cwt., the boiler pressure being 120 lb. to the square inch, and the total weight of the train, including the engine, being 37 tons 8 cwt. 3 qr. This time, however, the start was made from the bottom of the steepest incline, 1 in 18, situated at a distance of 600 ft. from the normal starting point, reducing thus the length of course to 1300 ft. instead of 1900 ft. Considering the construction of the wheels of Mr. Aveling's traction engine, this test was a most severe one, and the engine, in fact, began slipping from the very commencement of the trip. Referring to the detailed description and engraving of this engine on page 453 of our last volume, it will be noticed that the driving wheels have cast-iron tyres 6 ft. in diameter by 18 in. wide. The surface of each tyre is furnished with transverse recesses, which, however, do not extend right across the tyre, but leave a perfectly smooth circle in the middle of the latter, as shown by our transverse section of the engine. Owing to the rather strong curvature of the tyres, and the hard surface of the road, the wheels naturally only came into contact with the latter at the middle of their width, and this portion of the bearing surface became, by continued slipping, highly polished, and, as a matter of course, unfit for bite. Nevertheless the engine managed

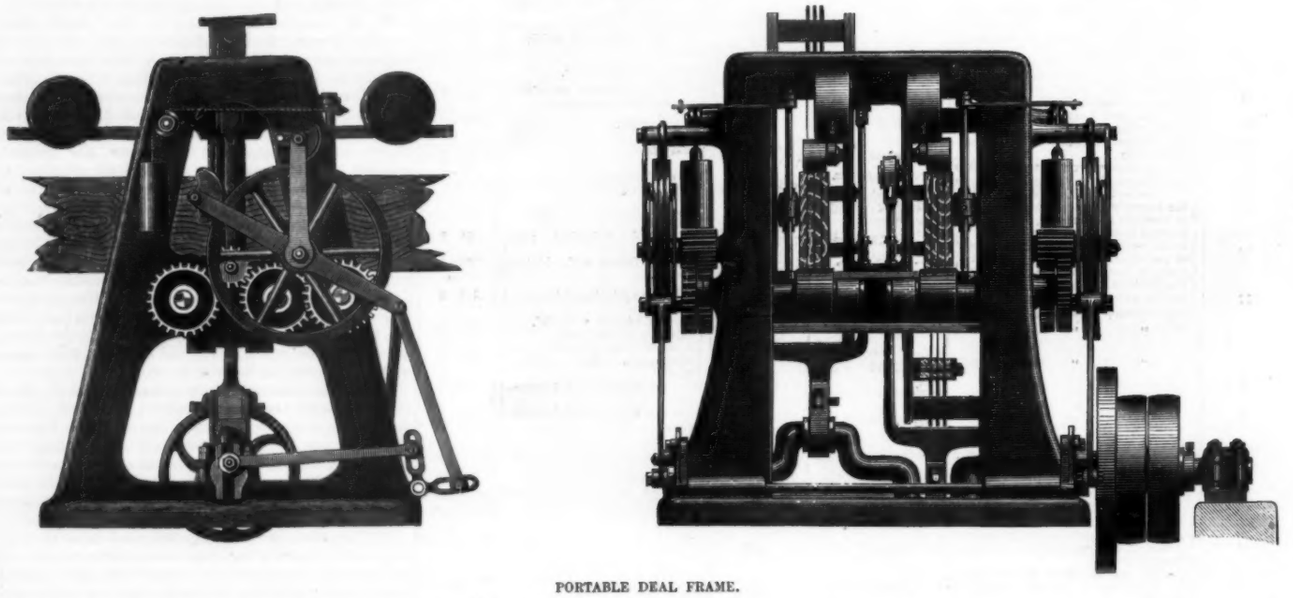
WOOD WORKING MACHINERY AT THE WOLVERHAMPTON SHOW.

CONSTRUCTED BY MESSRS. ALLEN RANSOME AND CO., ENGINEERS, LONDON.

(*For Description, see Page* 34.)



RANSOME'S "COMPLETE JOINER."



PORTABLE DEAL FRAME.

to reach the top of the incline, by doing her utmost, in 29 minutes. Messrs. Aveling and Porter's engine had, we may mention, 8 tons 10 cwt. 1 qr. on the driving wheels, while the load on the driving wheels of the "Sutherland" was 7 tons 11 cwt. 1 qr.

Meanwhile a pair of cast-iron driving wheels had been fitted to the "Sutherland," these wheels, we should mention, increasing the weight of the engine by about 15 cwt. Under these circumstances it was determined to make a run from the last starting point by applying two wagons and the portable engine, representing together a load of 18 tons. With this load, however, the engine was able to proceed but a short distance with much difficulty, and when it arrived on the next incline of 1 in 22, the iron tyres lost all hold on the ground, bringing the train to a complete standstill. The load was then reduced to 13 tons, by uncoupling the portable engine, and after this had been effected, the engine continued its course easily over the remaining portion of its journey, which occupied altogether 26½ minutes, including stoppages.

It will thus be seen that the same engine when furnished with india-rubber tyres was enabled—under the special circumstances of the present trials—to haul just double the load than could be taken with the smooth cast-iron tyres. That the elastic tyres have proved a success in this particular case we are glad to record, but on the other hand it is only fair to state that the comparative results obtained were not due to the india-rubber tyres alone, but also to the construction of the iron wheels against which they were pitted. The smooth faced cast-iron wheels are really the worst which can be employed on hard macadamised roads, as far as adhesion is concerned, a slight amount of slip imparting a kind of polish which renders their adhesion less than that of smooth wrought-iron tyres employed under similar circumstances, while the adhesion is of course still less than that of wrought-iron tyres with cross ribs, such as are fitted by Messrs. Aveling and Porter to the wheels of their 6-horse engines. It must be remembered that the india-rubber tyres were surrounded by their chain armour, and the elasticity of the tyres enabled the links of these chains to, as it were, interlock with the hard but slightly uneven surface of the road, thus securing an amount of grip far exceeding that obtained by the smooth-faced rigid tyres. The addition of cross pieces, or of a few square-headed bolts to the latter, however, would have vastly increased their holding power, and without practically injuring the surface of the road would probably have enabled them to exercise a hauling power equal or nearly equal to that afforded by the india-rubber tyres.

The particulars we have given show that in the trials at Tettenhall the india-rubber tyres enabled an engine having 7 tons 11 cwt. 1 qr. on its driving wheels to do with ease what an engine having 8 tons 10 cwt. 1 qr. on drivers with rigid tyres, could only do with difficulty; and so far the india-rubber tyres had a decided advantage. We have, in our foregoing remarks, expressed our opinion that this advantage was greater than it need have been had the rigid tyres been of a class better adapted for the work they were called upon to perform; but we nevertheless readily admit that on a hard macadamised road there is a decided advantage as far as adhesion is concerned, attendant upon the employment of the india-rubber tyres. But there is another and very important element to be taken into consideration, namely, the cost of these latter tyres. Buyers of traction engines naturally desire to obtain the greatest possible return upon the money they may invest, and the question thus arises whether the india-rubber tyres will give a commensurate return upon the expenditure they involve? The reply to this question, afforded by the recent trials at Wolverhampton, appears to us to be—as we expected it would be—a most decisive and unmistakable negative, as far as traction engines for working at moderate speeds are concerned. The price of the "Sutherland," with india-rubber tyres, is 750*l.*, while that of its competitor, Messrs. Aveling and Porter's 10-horse engine, is but 390*l.*, and in proportion to the capital invested, the latter therefore did by far the greater amount of work. Moreover, from experiments subsequently made (and of which we shall speak presently), there appears to be but very little doubt that the load taken up by the "Sutherland" would have been taken up with equal ease by a couple of Messrs. Aveling and Porter's 6-horse engines costing 300*l.* each, or together, 150*l.* less than the engine with the india-rubber tyres. As each of the 6-horse engines is

WOOD WORKING MACHINERY AT THE WOLVERHAMPTON SHOW.

CONSTRUCTED BY MESSRS. ALLEN RANSOME AND CO., ENGINEERS, LONDON.

(*For Description, see Page* 34.)

FIG. 1.

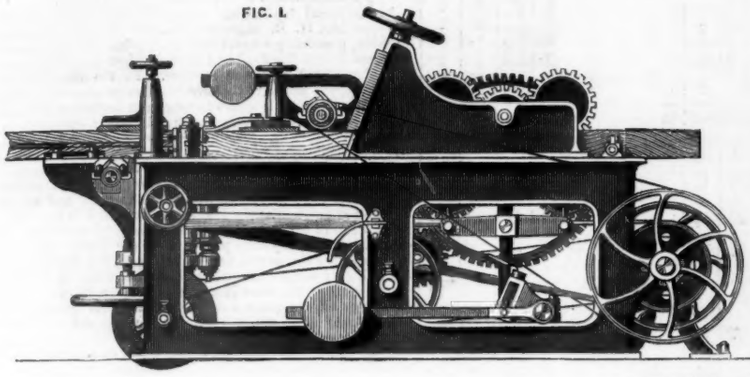


FIG. 2.

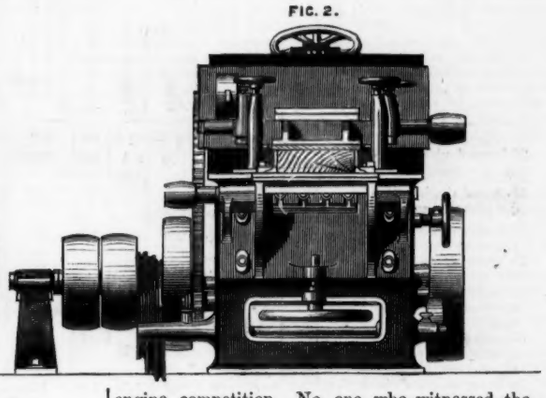
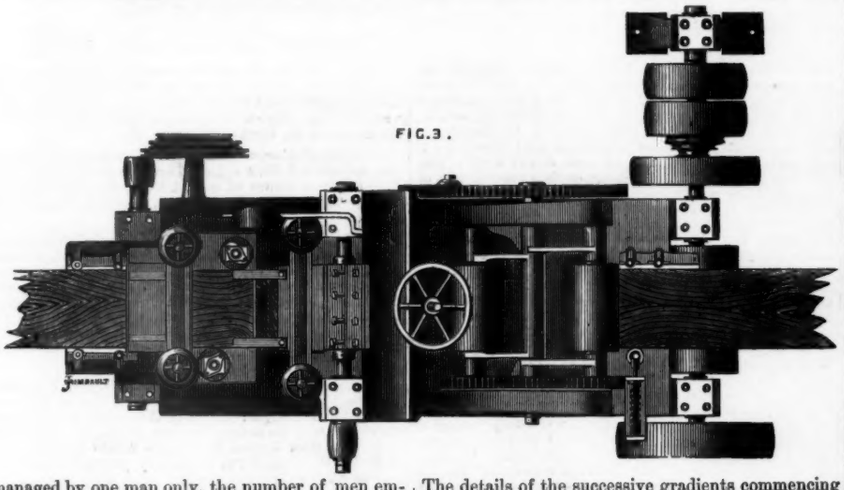


FIG. 3.



managed by one man only, the number of men employed with the two engines would be the same as with the single Thomson road steamer. Considered in this way the rigid tyre engines show themselves to be by far the most profitable investment, even when hard roads have to be traversed, while where there is much field work to be done, it has been clearly shown by the trials at Barnhurst that the india-rubber tyres not merely afford no benefits whatever, but actually interfere with the adoption of the appliances necessary for the effective haulage of a load over soft ground. Altogether the trials at Wolverhampton appear to have shown conclusively that india-rubber tyres are quite unadapted for use on agricultural locomotive engines; but that if they could be manufactured at far less cost than at present, or if their endurance for a long period of years could be insured, they might be beneficially adopted in cases where the main work of an engine would lie over hard macadamised roads. In the case of engines specially intended for working passenger traffic at a high speed, india-rubber tyres, even at their present price, may probably be advantageously employed; but we greatly doubt whether at present such engines can be beneficially used in the country at all, while the advantages to be derived from their employment abroad in place of light and cheaply constructed tramways worked by steam power, are, to say the least of the matter, doubtful.

We have already referred incidentally to some further traction experiments made on Messrs. Aveling and Porter's 6-horse engine, and of these experiments, which were carried out on Monday last at the request of some of the officials connected with the War Department, we must now proceed to give some particulars. The site chosen for the trial was a piece of good macadamised road close to the Show, the ground having an average rise of 1 in 12.24 for a length of 340 ft., the steepest gradient on this length being, however, 1 in 7.33. The details of the successive gradients commencing at the bottom of the rise are subjoined:

Distances from starting point.		Gradient.	Distances from starting point.		Gradient.
0 ft. to 25 ft.	...	1 in 13	150 ft. to 175 ft.	...	1 in 12.9
25 „ „ 50 „	...	1 „ 8.4	175 „ „ 200 „	...	1 „ 14.5
50 „ „ 75 „	...	1 „ 7.8	200 „ „ 250 „	...	1 „ 18.4
75 „ „ 100 „	...	1 „ 7.33	250 „ „ 275 „	...	1 „ 18.5
100 „ „ 125 „	...	1 „ 9.72	275 „ „ 300 „	...	1 „ 18
125 „ „ 150 „	...	1 „ 11.4	300 „ „ 340 „	...	1 „ 13.6

Up this hill Messrs. Aveling and Porter's 6-horse engine fitted with Mr. W. Bridges Adams's elastic tyres (illustrated by us in our last number but one) hauled a load of 7 tons 12 cwt., this load being composed of a timber wagon weighing 3 tons 8 cwt. and another wagon weighing with its load 4 tons 4 cwt. The weight of the engine in working order was, as stated by us last week, 5 tons 4 cwt. 2 qr., this making the total weight of the train 12 tons 16 cwt. 2 qr. When the steepness of the gradient is taken into consideration it will be seen that this is a considerably heavier proportionate load than that taken by Messrs. Aveling's 10-horse engine during the trial at Tettenhall; but it should be noticed that during the experiments of which we are now speaking a length of chain was employed between the engine and the wagons, so that the former and the latter were not at the same time on the steepest part of the road. Even when allowance is made for this, however, the performance is an exceedingly creditable one and shows the hauling power which may be obtained on hard roads by the employment of cross-ribbed wrought-iron tyres.

In concluding our notice of the various trials which have taken place at Wolverhampton, it is our pleasant duty to speak of the awards of prizes to which those trials have led. As the readiest way of placing these awards before our readers, we have collected them in a tabular form on page 21. Referring to this Table, it will be seen that Messrs. J. Fowler and Co. have carried off all the first prizes for steam ploughing tackle, while Messrs. Aveling and Porter have been the winners of the traction engine competition. No one who witnessed the various trials will deny that in both cases the honours won have been most heartily deserved.

We have now to speak of the Show proper, and we may, in the first place, say a few words concerning the site on which it is held. The showyard, then, is situated on a portion of the Wolverhampton racecourse and the land adjoining it, and as far as situation goes, the site is well chosen, as it is distant but little more than half a mile from the heart of the town, and is thus readily accessible. But it so happens that until within the last few months the land constituting the showyard has been irrigated by the sewage of the town, and thus the top layer of the ground consists in a great measure of deposited matters, which have only been rendered tolerably solid by the past few months' drainage. The effect of the recent heavy rains on such a soil as this may be readily imagined, and when it is remembered that the ground has also been cut up by the cartage of heavy goods, and the passing to and fro of traction and steam ploughing engines, it will be understood that its state was on the whole not particularly favourable to foot traffic. On Monday last, indeed, the drying influence of a warm sun made the ground tolerably solid; but the heavy rains of Monday night and Tuesday soon reduced it to its former state of morass, and on the last-mentioned day some portions of the ground were scarcely passable to foot-passengers, while on almost all parts a species of "bog-trotting" of a very disagreeable kind had to be performed by the visitors. Of the state of the ground on Wednesday and yesterday we had no personal experience; but we understand that it had somewhat improved. The miserable state of the weather may perhaps have had its influence on us in forming our opinion, but it certainly appears to us that, taken as a whole, the Wolverhampton Show has proved inferior in interest to those at Oxford and Manchester. It is not merely that it contains a few less stands and exhibits, for that is a comparatively small matter, but it appears to us to contain fewer evidences of advancement, and certainly fewer novelties. The distinguishing features of the exhibits it contains consist indeed principally in improvements of details of construction, rather than in the introduction of new principles or really novel appliances. We shall, however, not say more on this point at present, but proceed with our description of the leading exhibits, merely giving first the following list showing the comparative number of stands and entries at the Wolverhampton and three preceding Shows:

		Stands.		Entries.
1868, Leicester	...	337	...	6369
1869, Manchester	...	395	...	7724
1870, Oxford ...	...	406	...	7851
1871, Wolverhampton		363	...	7650

STEAM PLOUGHING ENGINES AND CULTIVATING MACHINERY.

Foremost amongst the exhibits in this class, of course, come those of the great Leeds firm. Messrs. J. Fowler and Co. were always noted for the excellent show they make at the Royal Agricultural Society's meetings; but at Wolverhampton they have far exceeded their average performance in this respect. Altogether they sent no less than fourteen engines for exhibition and trial, ten of these being steam ploughing and the remaining

PARTICULARS OF PLOUGHING AND TRACTION ENGINES EXHIBITED BY MESSRS. J. FOWLER AND CO.

CLASS.	Diameter of cylinders.	Stroke.	Heating surface. Firebox.	Heating surface. Tubes.	Heating surface. Total.	Firegrate area.	Average steam pressure.	Speed of engine in revolutions per minute corresponding to the speeds in the next three columns.	Speed of ploughing rope in miles per hour.	Road Motion; speed in miles per hour. Quick gear.	Road Motion; speed in miles per hour. Slow gear.	Driving wheels. Diameter.	Driving wheels. Width of tyres.	Weight of engine in working order.	Capacity of tanks.	Capacity of coal bunkers.
	in.	in.	sq.ft	sq. ft.	sq. ft.	sq.ft	lb.	rev.	mile	mile	miles	ft. in.	in.	tons	gals.	c. ft.
20-horse double cylinder ploughing engine	9	12	47	193	240	9.8	100	150	2¼	2½	1½	6 0	20	16	254	15
20-horse single cylinder ploughing engine	13	14	44	234	278	9.6	100	130	2¾	2	one gear only	6 6	22	17	290	16.6
14-horse double cylinder ploughing engine	8	12	38.6	161.4	200	7.69	100	150	2¾	2½	1½	5 6	20	14	200	13.5
12-horse single cylinder ploughing engine	10½	12	33.3	161.	194.3	7.69	100	150	2¾	2½	1½	5 6	20	14	187	11.5
12-horse single cylinder ploughing engine with clip drum	10½	12	33.3	161.	194.3	6.24	100	150	2¼	2½	1¼	5 6	14	12	159	25.4
8-horse single cylinder double drum ploughing engine ...	9½	12	33.3	139	172.3	6.24	100	150	2¾	2½	1¼	5 6	14	12½	135	10.
12-horse single cylinder traction engine	10½	12	38.6	119	157.6	7.69	100	150		2½	1½	6 0	18	11	225	13.5
6-horse single cylinder traction engine	7½	10	24	90	114	3.6	100	160		3	1½	5 0	14	7½	126	12.5

four traction engines. The principal dimensions of these various engines are given in the annexed Table, and all we have to do here, therefore, is to speak of their general construction. Six of the engines—namely, a pair of 20-horse single cylinder, a pair of 20-horse double cylinder, and a pair of 12-horse single cylinder engines—are constructed for working on the double-engine system, in which the two engines of a pair traverse the opposite headlands, and work alternately, drawing the implement to and fro between them. This is undoubtedly by far the best system of working yet introduced, and its employment is daily extending. Next, there is an engine fitted with the clip-drum for working on that system, in which the implement is attached to an endless rope, and hauled to and fro between the engine and a travelling anchor on the opposite headland. In this case, to allow for variations in the distance between headlands, the implements have to be fitted with an arrangement of slack gear, which maintains a constant proportion between the tensions of the hauling and tail rope, however the length may vary. This very ingenious yet simple gear has already been described in our pages. The travelling windlass used in connexion with this tackle consists simply of a sheave resting on six rollers of small diameter, these rollers having each a thin disc flange, which cuts into the ground, and affords the necessary lateral resistance. The movement of the anchor along the headland is effected by simple winding gear, which hauls upon a wire rope attached to a fixed anchor suitably placed, and which derives its motion from the main sheave through the intervention of a friction clutch.

The third arrangement of tackle represented by Messrs. Fowler's exhibits is the double drum set, in which a single engine, fitted with two winding drums, is employed to haul an implement backwards and forwards between itself and a travelling windlass, as in the clip-drum set, the two winding drums alternately coiling and uncoiling the wire rope. The travelling windlass is of similar construction to that employed with the clip-drum tackle. In working on this system the engine may also, if desirable, be kept outside the field, the rope being then best laid out in a triangular form, and the implement being hauled to and fro between two moving anchors along the far side of the triangle.

The fourth and last arrangement illustrated by Messrs. Fowler is the well-known roundabout system, a set of tackle for which is exhibited as well as a traction engine suitable for driving it.

Messrs. Fowler have for a long time past employed steel extensively, and very successfully, in the construction of the shafts, drums, and gearing of their engines, and at the present show we find the double-drum engine and two 6-horse traction engines with steel boilers also. We have also to notice the increased use of single-cylinder engines even for the larger sizes. The cylinder in these engines is arranged at the front end, and jacketted on Mr. Aveling's plan, while the crank shaft being at the hind end, the fly-wheel is conveniently situated for the driver to start the engine in the event of its stopping on one of the centres. Most of Messrs. Fowler's engines are fitted with link motion, but two of them—namely, a 14-horse double-cylinder engine and a single-cylinder traction engine—are fitted with Mr. Max Eyth's ingenious yet simple valve gear, illustrated and described by us on page 267 of our last volume. This gear is very easily handled, and indicator diagrams taken from engines fitted with it show excellent results. Altogether, Messrs. Fowler pay great attention to the proportions of the valve and gear fitted to their engines; and while at Wolverhampton we had an opportunity of inspecting a number of diagrams taken from their engines, these diagrams being the most perfect its has ever been our fortune to see taken from engines fitted with link motion.

Lastly we must mention that in the majority of Messrs. Fowler's engines the cast-iron or steel brackets formerly used to support the crank shaft and countershaft bearings have been abandoned in favour of the system of construction lately introduced by Mr. Aveling, and described by us in our account of Messrs. Aveling and Porter's traction engines in our last number but one. According to this plan the side-plates of the firebox are extended, so as to carry all the plummer blocks, and the result is a material reduction of weight, and a thoroughly good and substantial job. Of the traction engines exhibited by Messrs. Fowler we shall have more to say in the proper place, and we need merely remark here that both they and the ploughing engines are examples of thoroughly first-class workmanship.

Regarding the various implements to be used with the steam cultivating tackle our space will permit us to speak but briefly this week; but we must nevertheless say a few words concerning the examples which we illustrate on pages 30 and 31 of the present number. On the former page the upper figure shows an 11-tine turning cultivator of a class now largely used by Messrs. Fowler. This implement has been on several occasions spoken of by us, but since we last described it in detail, and explained its action an improvement has been made in it which deserves special comment. This improvement consists merely in making the lever to which the ropes are attached of a forked shape, as shown. In use that arm of the fork to which the hauling rope happens to be attached is of course brought into a direct line with the strain, while the other arm is thereby caused to project laterally, thus bringing the tail rope clear of the wheels, and causing it to be in a favourable position for turning the implement when the headland is reached. The tail of the draught lever is coupled to a short chain, and when on arriving at a headland the strain is transferred to what was previously the tail rope, and the draught is thus brought at right angles to the implement; this chain is tightened, and by acting on a segment, turns the main axle which is cranked, and this, by depressing the supporting wheels, lifts up the main frame, and raises the tines clear of the ground. The tines being maintained in this position by a lever and catch, the turn is readily made, and on its being accomplished the steersman allows the frame and tines to fall again, and the implement starts on a fresh journey. The action of this turning arrangement is admirable. The turns are made with great promptness, and within a very limited space, while the implement is altogether thoroughly manageable, and there is nothing about it liable to get out of order.

The turning harrow, 15 ft. wide, also illustrated on page 30, is constructed on the same system as the cultivator just described, and therefore requires no special explanation. We may remark, however, that the arrangement gives a light implement which may be made almost any desired width, and which is readily steered and managed.

The combined seed drill and harrows, illustrated on page 31, is also constructed on the turning system. In attempting to drill by steam power the chief problem is how to utilise the great power available without giving to the implement an impracticable width. Messrs. Fowler have solved this problem by combining the harrowing and drilling apparatus, the implement we illustrate being constructed so as to perform through harrowing or light cultivating before the drilling and the harrowing in of the seed after the drill has passed. The construction of this very useful implement, which is adapted for harrowing and drilling a width of 10 ft., will be readily understood from our engraving without further explanation on our part.

Another of our illustrations on page 30 shows a powerful balance implement for extracting roots and stones. It consists merely of a three-tine balance cultivator of unusual strength, the parts being so proportioned that if the implement encounters an immovable obstacle, it is capable of stopping the engine without fracture. It can, if desired, be worked with two or even one tine only, and is a very useful implement for preparing rough ground. The last of our illustrations shows one of a class of small three-wheeled wagons, weighing 32 cwt. each empty, and capable of carrying 3 tons. The draught bars are arranged so that the pull does not come through the fore carriage, or any other part of the wagon, but it is thrown upon a continuous bar, which extends from one end of the wagon to the other, and thus serves to transmit the pull throughout the train. Of a modified form of these three-wheeled wagons we shall have more to say on an early occasion.

Of the remainder of Messrs. Fowler's implements want of space compels us to defer an account until our next number, when we shall also describe the other exhibits of interest at the Wolverhampton Show.

MARSDEN'S STONE BREAKER.

At the Royal Agricultural Society's Show held at Oxford last year, Mr. H. R. Marsden exhibited a stone breaking machine, possessing a novel and useful feature. Originally the serrations in the fixed and swinging jaw were so disposed that they fitted into one another. In the improvement alluded to, the points of the serrations were placed opposite each other, so that all stones having been broken to a certain extent could drop through the small square openings between the serrations. This machine we described and illustrated on page 55 of our tenth volume. At the present Agricultural Show at Wolverhampton, Mr. Marsden exhibits another improvement in his stone breaker, which we illustrate on page 19. It will be seen that both the fixed and swinging jaws are curved at the lower ends, so that it is impossible for any stones to drop through the openings made by the serrations until they have passed along the curved paths of the jaws. Again, as will be seen in Fig. 4, the serrations in the swinging jaw are curved at the bottom from left to right, whilst those on the fixed jaw, as will be seen by the dotted lines, curve in the reverse direction. By this arrangement the stones are subjected to a number of compound cuts, which effectually prevent any piece of undue size falling through, and of course the gauge to which the stones are broken is rendered much more reliable by this simple but highly important improvement in the stone breaker.

FOREIGN AND COLONIAL NOTES.

Belgian Railway Plant.—Tenders have just been received for forty open railway trucks for the conveyance of rails (10 tons each), for the Belgian State lines. The tenders, which were all from Belgian firms, ranged from 3512*l.* to 3920*l.* The frames of the trucks are to be of iron.

Canadian Railways.—The length of railway now in operation in Canada is 2679 miles. There are further 920 miles more of line in course of construction. The principal new line on hand is the Intercolonial, which is 400 miles in length.

The Suez Canal.—It appears that during 1870 the number of vessels passing through the Suez Canal was 491. Of these 391 were British, 75 French, 32 Egyptian, 26 Austrian, 18 Turkish, 9 Italian, 3 Spanish, 2 Dutch, 2 Portuguese, 1 American, 1 Russian, 1 Danish, 1 Greek, and 1 Zanzibarian. The total mercantile tonnage which passed through the canal during the year was 409,192 tons, increased by Government vessels and yachts to a grand total of 436,498 tons.

Darien Canal Surveys.—The Darien Canal Expedition has closed its labours. The line from the Gulf of Darien to the Gulf of San Miguel has been thoroughly surveyed, and the character of the country has been completely ascertained. The route from Cupica Bay to the Atrato by way of the Napipi river is believed to be the only practicable one for a ship canal.

Surveys of Manitoba.—Mr. Stoughton Dennis, the surveyor-general of Manitoba, has left Ottawa for Toronto, and it is said that he is about to despatch some surveyors to settle at once the boundaries of the settled districts of the new province. The laying out of new townships will not be commenced, however, until the Indian reservations are settled.

Tramways in Constantinople.—The Constantinople Tramways Company has commenced working. Its carriages are similar to those in use on Parisian tramways.

Montreal and Ottawa Junction Railway.—Mr. Legge, C.E., and Mr. Malsbury, C.E., have made a general examination of the country through which the Montreal and Ottawa Junction Railway will run. The grades are found to be easy, and it is stated that a cheap road can be constructed. It is proposed to arrange for a union station at Ottawa in connexion with the Canada and Central Railway.

Growth of Halifax.—It is remarked that Halifax, Nova Scotia, is gradually extending its boundaries. The city has been creeping further and further to the north, the west, and the south. With the opening of the additional railway communication now nearly completed, a great future seems in store for Halifax.

Northern of Spain Railway.—The net profit realised last year upon the Northern of Spain Railway was 445,576*l.* This sum provided for the charges attending the priority obligations of the company, and left a balance of 61,927*l.* Of this balance, 49,047*l.* was applied to the execution of sundry supplementary works. The company has not yet settled accounts with its contractors.

Toronto and Muskoka Junction Railway.—This line is expected to be opened as far as Orillia by the middle of October. The bridges on the line, of which Mr. Ginty is contractor, are of cut stone. The line will probably be absorbed eventually by the Northern of Canada.

French Ocean Steamers.—The capital represented by the fleet of the French Transatlantic Steam Navigation Company amounts to 2,760,000*l.* The company owns 20 ships, costing on an average 120,000*l.* each. The company insures its own ships; and notwithstanding the loss of one steamer (the Darien), its insurance account showed a profit last year of 24,159*l.* This sum was carried to the general insurance fund, which was thus increased to 117,693*l.*

THE ST. LOUIS BRIDGE.

On page 26, we give a perspective view of the west abutment, and about two-sevenths of the shore span of the stupendous bridge now being constructed across the Mississippi river at St. Louis. This engraving will give our readers a much better idea of the magnitude and beauty of this remarkable work than anything yet published. The proportions of the bridge may be inferred by comparing them with the figures on the side of the river beneath the arches. The individual standing with his back against one of the small piers, with arms folded, surveying the father of waters as he rushes past the city, is only about as high as two and a half courses of the granite masonry of the pier, and he stands about 90 ft. below the carriage-way of the bridge. Seventy feet above him the iron horse is seen with its cloud of smoke emerging from the sandstone arcade which surmounts the five stone arches that carry the viaduct over the St. Louis wharf. The railway tracks are below the carriage-way and foot walks, and the steam trains will in no manner interfere with the local traffic of St. Louis, as the bridge is connected with a tunnel under the city.

The towers which terminate the bridge proper at each end of the structure, will contain elevators and stairways for the convenience of pedestrians on the wharfs on both sides of the river.

In former issues we have given full descriptions of this remarkable work, and to those we refer the reader for further information.

The St. Louis Bridge when completed, will be found, if compared with other great bridges of the world, to surpass them all in several important particulars. In architectural effect none of them will equal it. It will be superior to the Britannia Bridge over the Menai Straits, to the Victoria of Montreal, or the Kuhlenburg in Holland, and in fact will equal in beauty the smaller gems that adorn the Thames and the Seine.

In the massiveness of its masonry and the depth of its foundations, it stands. One of its channel piers and one abutment pier stand on the marble bed rock over 100 ft. below the river's surface. In the length of its spans there is nothing equal to it in existence, except suspension bridges. Its two shore spans will be 500 ft. each, in the clear of masonry, and the middle one will be 520 ft.

In capacity it far excels all others yet constructed or designed. The Brooklyn Suspension Bridge, one of the remarkable works of the age, with its 1600 ft. span, is only designed to accommodate local traffic, and will not possess sufficient strength to sustain steam trains. The suspension bridge about to be constructed over the Hudson, at the Highlands, is only calculated to carry one railway track across the river on its grand span of 1600 ft.; but the business that will be borne across the Mississippi by the St. Louis Bridge will greatly surpass that of any other. Already thirteen important lines of railway wait for its completion to throw their traffic across its noble arches; and above their trains, on a wide street, will roll the domestic commerce of the largest inland city in America. One of the widest and most central avenues of St. Louis will be extended by it directly across the Mississippi, thus connecting, by a common highway, two of the most prosperous and fertile states in the confederacy, Illinois and Missouri.

It is rare, indeed, that so many circumstances conspire to justify and carry into execution such magnificent engineering designs as this one. The great natural difficulties to be overcome were of a character so unusual that even the stringent legal conditions imposed to protect the navigation of the river added nothing to them, except in the clear height of 50 ft. required above high water. The law commanded that there should be either one span of 500 ft., or two of 350 ft. each. The remainder might be only 250 ft. each. After careful estimates the engineer satisfied himself that, because of the costly character of the foundations, the greatest economy lay in using no spans of less than 500 ft. Many efforts were made to discredit this bold design, but Mr. Eads fortunately possessed the confidence of enterprising capitalists in St. Louis and in New York city to such a degree that they could not be shaken in their faith in his ability to execute his designs, and the work was begun, and is now being rapidly pushed to completion. Already all the chief foundations are in, and the masonry is so far advanced as to be waiting for the superstructure.

The arches will be formed of crucible cast steel, which is now being made at the Wm. Butcher Steel Works in Philadelphia. This steel will be of superior quality, and but little inferior to that used in making the finest cutlery. It is required to stand a test of 60,000 lb. in compression per square inch without taking a permanent set, and each piece will be tested to that strain before it is accepted. This great strength in the steel makes its use cheaper than iron would be. The sustaining members of steel are arranged in the form of the staves of a cask, six staves forming a tube 18 in. diameter, and nearly 12 ft. long. These tubes constitute the arches, and the manner of their construction will be seen by examining the drawing. They will be enormously strong, the maximum burden being supposed to consist of the upper roadway or street, densely packed with people, and the railway tracks covered from end to end with locomotives. The total strength of the bridge is estimated to be equal to six times this burden.

We have published all of the very elaborate reports of the engineer of this bridge, *in extenso*, in advance of our contemporaries on both sides of the Atlantic, although we happen to know that they were favoured with copies by mail at the same time with ourselves. We give this, engraving also, in advance of them, and we shall endeavour to keep our readers informed, from time to time, of the further progress of this interesting work. The rapidity with which its grand piers were sunk to the deep bed rock of the Mississippi, and the remarkable freedom from accident or disaster that has attended the work, have elicited the surprise and admiration of engineers all over the world. No work of the same kind during this century has been more fruitful in developing novel and successful devices and appliances to insure the safe and rapid construction of massive foundations, or has contributed more largely to our store of practical and scientific knowledge of the science of bridge building than the structure we illustrate.

TITANIUM AND IRON.

TO THE EDITOR OF ENGINEERING.

SIR,—In your issue of June 16th, Mr. R. F. Mushet has a letter in which the following paragraph occurs: "Titaniferous iron ores have been smelted in Lancashire and Cumberland ever since blast furnaces have existed there, yet I have never heard that the red hematites were classed as titaniferous, though I have found that substance abundantly in them and the hearths of the furnaces bear witness fully to this fact. That the hematite iron is quite unrivalled for its excellence is pretty well known, and it owes that excellence to the titanic acid combined with the red hematite iron ores from which it is smelted."

Having had considerable experience in the analyses of Lancashire and Cumberland red hematites, I was rather astonished to hear that titanic acid was found "abundantly" in them—in fact, so sceptical upon the point that I have since analysed several of the most important ores, but have failed to detect any titanic acid whatever in them. The compounds of titanium found in the hearths of the furnaces is accounted for by using Irish ores which generally contain 2 or 3 per cent. of titanic acid.

Russian iron of the best description is being made in Middlesbrough from nothing but Lancashire and Cumberland red hematites containing no titanic acid, therefore, that substance does not appear to be necessary for the production of hematite iron "unrivalled for its excellence." I would be glad to know from what particular part of Lancashire and Cumberland the titanic red hematites are got.

I am, Sir, yours truly,

Middlesbrough-on-Tees, July 6, 1871. E. S.

CIVIL ENGINEERS IN INDIA.

TO THE EDITOR OF ENGINEERING.

SIR,—Every one must agree with your remarks on this subject in your issue of May 12, which has just reached me. Undoubtedly the grievances sought to be remedied by the recent memorial to the Secretary of State are substantial ones, more especially the one relating to furlough, &c. As it at present stands, the rule is sufficient, in itself, to deter men from entering the service. The grievance is so obvious that it will surely be removed as soon as the Government at home recognises the number and influence of the civil engineers that are in its employ; there being, according to the memorial, more than three to one as compared with Royal Engineers in the P.W.D. As it is comparatively recently that so many civil members of the profession have been taken into Government service, the fact does not seem to be properly appreciated that they form the majority in the P.W.D. You rightly say, "the reform asked for cannot be much longer withheld." In addition to this great and unfair advantage, and notwithstanding Notification No. 341, of October last, which professes to equalise the pay of the civil and military members, Royal Engineers still draw military pay in addition to their departmental salary. A military officer and a civilian being of the same grade, the officer will be drawing more pay than the other, for doing exactly the same work. This unjust anomaly is likely to produce and maintain in the mind of the civilian a sense of injustice on the part of Government which is prejudical to the interests of all concerned. Again, Government displays great partiality, and militates against its own interest in the distribution of new appointments, and notably in forming the staffs for the new State Railways now in course of construction, and under survey. It seems that when a lieutenant of Engineers, because he wants a change or an increase of pay, volunteers for employment in the P.W.D., if he has held his commission for a few years, he is at once appointed to an executive grade, or at least to an assistantship of the 1st grade. But, on the other hand, for a civil engineer, who perhaps has been in actual practice of his profession for ten or fifteen years, the Government has only, at the best, a 1st class assistantship available, making him subordinate to the lucky individual, many years his junior in age and experience, who happens to hold the Queen's commission. Far be it from me to say one word against the engineer officers themselves, for, "honour to whom honour is due," I do not believe that Government anywhere has a more faithful and zealous body of servants than the Royal Engineers in the P.W.D. But civil engineers have a just cause of complaint against Government in not being placed on the same footing, and given the same advantages, as the military members possess, and as are enjoyed, moreover, by every other uncovenanted service in India. It is very discouraging to young civil engineers who, like myself, look forward to a long term of service under Government, and residence in this country, to know that they are, and will be, weighted in the race. This is a subject which requires ventilation and discussion, and much good may be done through your journal, which is generally read and acknowledged as the organ of the profession throughout India as elsewhere; and you, Sir, by taking up our cause and advocating our just claims will earn the thanks of every civil engineer in India.

I am, Sir, yours truly,

ONE OF THE SUFFERERS.

PATENT SPECIFICATION ABRIDGMENTS.

The abridgments delivered at the Patent Office by the applicants for letters patent will in future be published weekly (commencing on Friday, July 14), with indexes of persons and subjects. In the body of the work the abridgments of the provisional and complete specifications will be published in regular numerical order at the expiration of the term of six months from the date of application. But each weekly number will have an appendix containing the abridgments open to public inspection before the expiration of the term of six months, in consequence of the patentees having filed their final specifications, and also the abridgments of complete specifications just received. These abridgments will be subsequently printed in the body of the work in their proper places, in order to preserve the numerical and chronological arrangement of the book. In the indexes of each successive number, all the previous indexes will be incorporated until the end of the year; and then the last indexes only should be retained to bind with the fifty-two weekly parts in one volume for the year.

PRIVATE BILLS IN PARLIAMENT.

Very little private business in the way of third readings has taken place in either of the Houses since our last report. The only Bills of interest to our readers which have been read a third time in the House of Lords and passed were the Sligo and Ballaghaderreen Junction Railway Bill, the Southern Junction Railway Bill, and the Bradford Canal Bill.

Last Friday, before the House of Lords Committees, the preamble was proved of the Great Northern Railway Bill. This is a Bill to transfer the undertaking of the Bradford, Eccleshill and Idle, and the Idle and Shipley Railway Companies to the Great Northern Railway Company; to authorise the construction of new branch railways in the West Riding of York, and for a deviation at Bourn. The length of this proposed new line is to be 8 miles 63 chains; and the deviation 20 chains. The capital proposed to be raised is 350,000*l.* by shares and 116,600*l.* by loan. In the case of the West Lancashire Railway Bill the Committee decided that certain of the petitioners had no *locus standi* before them. The opposition of the other petitions was then withdrawn. The object of this Bill is to incorporate a company for making railways from Southport to Preston, and connecting lines with the North Union, and Lancashire and Yorkshire Railways; to give running powers to the existing company over portions of the North Union and Lancashire and Yorkshire Railways, and for working arrangements with the London and North-Western and Lancashire and Yorkshire Railway Companies. The length of the new line proposed is 17 miles 30 chains, and the capital proposed is 175,000*l.* by shares and 58,800*l.* by loan.

The preamble was not proved in the case of the Edinburgh and District Water Bill. This has been the hardest fight of the session, and was a Bill to empower the Edinburgh and District Water Trustees to construct new waterworks, and take water from St. Mary's Loch and the loch of the Lowes, and to extend their limits of supply. The capital proposed to be raised was 500,000*l.* by loan. The preamble was proved of the Killorglin and Farranfore Railway, and Bill reported specially with amendments. This is a Bill for making a railway from a junction with the Great Southern and Western Railway of Ireland at Farranfore Station to the Quay on the east side of the River Laune at the bridge of Killorglin, to enter into traffic arrangements with the Great Southern and Western Railway Company for the use of stations, &c. The length of this line is to be 11 miles 60 chains, and the capital proposed is to be 40,000*l.* by shares, and 20,000*l.* by loan.

On Monday, before the House of Lords Committees, the preamble of the Mersey Railway Bill was proved, and the Bill reported with amendments. The object of this Bill is to authorise the company to divert a portion of their authorised line, and to connect it with the existing railways at Liverpool and Birkenhead, and to extend the time for the compulsory purchase of lands, and the completion of other portions of the authorised line, and to authorise working agreements with neighbouring railway companies. The length of the line is to be 2 miles 31 chains. The preamble was also passed of the Bradford and Thornton Railways Bill. This is a Bill to incorporate a Company for making railways from Bradford to Thornton and Little Horton, and to authorise the company to use portions of the Lancashire and Yorkshire and Great Northern Railways. The length of this line is to be 7 miles 7 chains, and the proposed capital to be raised is by shares 275,000*l.*, and by loan, 91,600*l.*

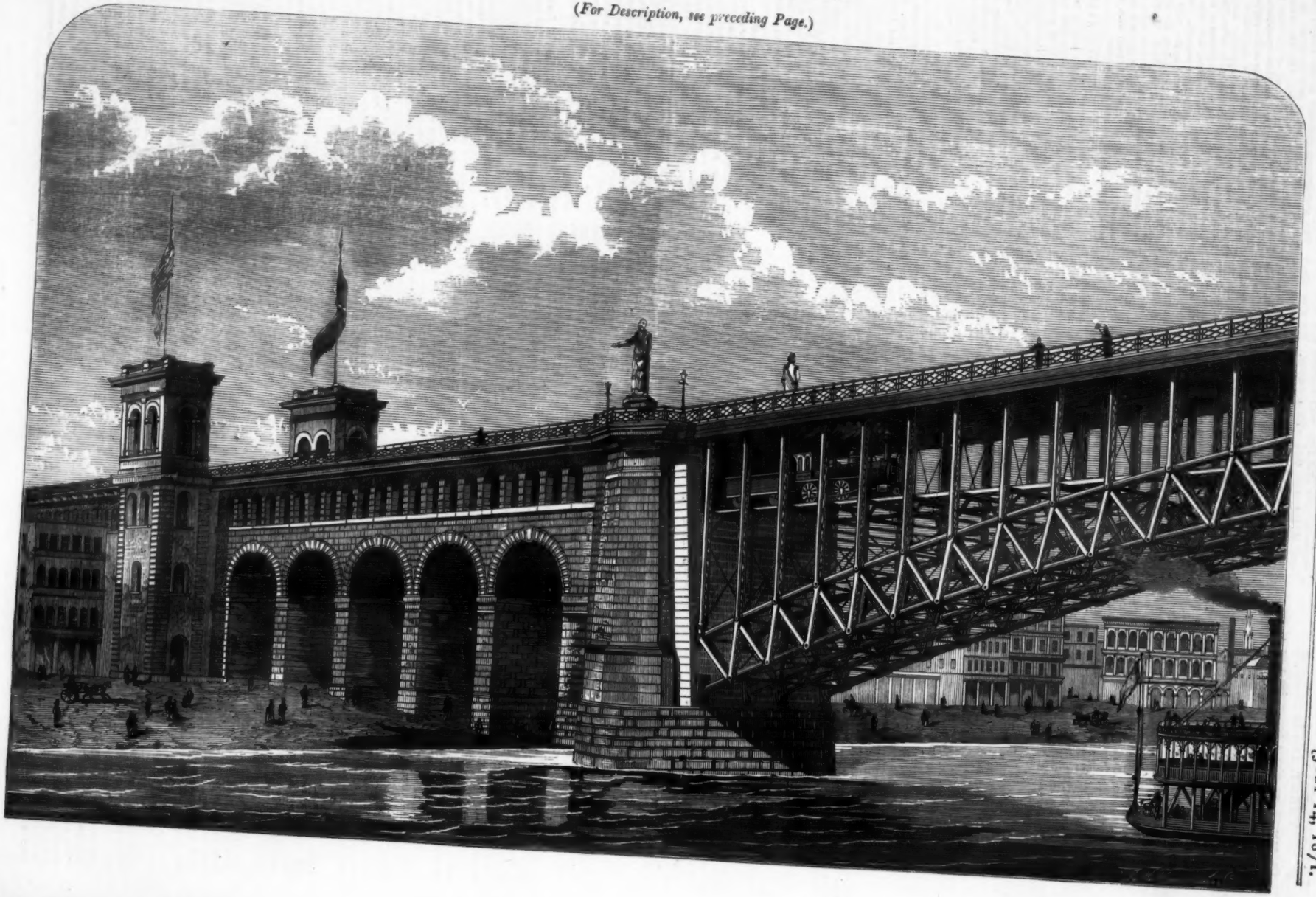
On Tuesday last, before the House of Lords Committees, the preambles were proved of the Harrow, Edgeware, and London Railway, and the Lancashire and Yorkshire Railway (New Works) Bills. The first of these Bills is to enable the company to make a railway from their authorised railway at Edgware to the Midland Railway, in the parish of Hendon, and to enter into traffic arrangements with the Great Northern and the Midland Railway Companies. The length of this line is to be 1 mile 40 chains, and the capital to be raised is to be by shares, 21,000*l.*, and by loan, 7000*l.* The opposition to the second Bill was withdrawn when originally before a Committee on opposed Bills when the objects of the Bill were reported.

On Wednesday, before the House of Lords Committees, the preamble was proved of the East London Railway Bill. The object of this Bill is to authorise the abandonment of certain portions of the line, and to deviate from the levels of other portions, to authorise the existing company to purchase, and take for the purposes of the deviated portions, an easement, or the right of constructing a railway by tunnel in lieu of purchasing absolutely the land. In the case of the Kent Coast Railway, which is a Bill to authorise the discharge of a receiver in the Court of Chancery of the undertaking of the company, to alter, and define the rights and priorities of stockholders, and to make provision with respect to the sale of the undertaking to, or the amalgamation of the existing company with the London, Chatham, and Dover Railway Company. The preamble was proved.

THE WEST ABUTMENT OF THE ILLINOIS AND ST. LOUIS BRIDGE.

CAPTAIN JAMES B. EADS, ENGINEER.

(*For Description, see preceding Page.*)



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NOTICE OF MEETING.

THE AERONAUTICAL SOCIETY OF GREAT BRITAIN.—General meeting at the Society of Arts, July 17th.

CONTENTS.

	PAGE
The "Waterstaat" of Holland	17
Bauschinger's Indicator Experiments on Locomotives	18
The Royal Agricultural Society's Show	19
Marsden's Stone Breaker	24
The Wolverhampton Show; Messrs. Fowler and Co.'s Exhibits	24
Foreign and Colonial Notes	24
The St. Louis Bridge	25
Titanium and Iron	25
Civil Engineers in India	25
Patent Specification Abridgments	25
Private Bills in Parliament	25
Indian Engineering College Examination	27
Boiler Explosions	27
Practical Electricity	28
Literature	29
Shoeburyness Experiments	29
Plaster of Paris Manufacture	29
Notes from Paris	32
Notes from the South-West	33
Notes from the North	35
Notes from Cleveland and the Northern Counties	34
Berryman's Water Regulator	34
Ransome's Wood-Working Machinery	34
Light Railways	35
Peat Fuel	35
The New Docks at New York	36

ENGINEERING.

FRIDAY, JULY 14, 1871.

BOILER EXPLOSIONS.

THE labours of the second Committee upon Boiler Explosions have come to an end, and its report has been submitted. It will be remembered that a Select Committee was appointed last year, and that in June and July it held many sittings, received much evidence, and finally recommended that another Committee should be appointed at the ensuing session to conclude the work of investigating the subject. On the 25th of April last this second body finished its work, and on the 20th of June, sent in the report. One of the conclusions arrived at is, that a general system of boiler inspection cannot be insured without making that inspection compulsory, and the Committee is not prepared to recommend for adoption any system of this nature.

This conclusion is arrived at partly because it is believed a large number of explosions occur annually from causes that are and would continue to be independent of anything that could be prevented by periodical inspection, and partly because it is considered doubtful whether compulsory inspection would not lessen the responsibilities of owners, and tend to make them careless as to the class of men they employ.

The most important recommendation contained in the report is, "that it be distinctly laid down by statute that the steam user is responsible for the efficiency of his boilers and machinery, and for employing competent men to work them, and that in the event of an explosion the onus of proof of efficiency should rest on the steam user." It is also recommended that as an average coroner's jury cannot satisfactorily investigate the causes of an explosion without the aid of competent professional advice, that whenever an explosion occurs, the user shall report the same to the district coroner, who shall communicate with the Board of Trade, which shall instruct one of their competent surveyors to attend the coroner and assist him in his investigation.

Among the resolutions proposed were those having reference to the inspection of new boilers, as follows:

"That it is desirable that a preliminary inspection of boilers should take place, so as to secure:

"(*a*) That the boiler is capable of bearing a working pressure equal to that at which it is intended to be worked.

"(*b*) That it has all necessary fittings to prevent the steam ever attaining a greater pressure than that prescribed, and to secure a proper supply of water to the boiler.

"(*c*) That the boiler is so fixed as to afford ready means for external examination.

"That an inscription should be put up on a conspicuous part of every boiler to the effect that, when new or last examined, it was testified to be fit to work up to a certain pressure, to be therein stated."

Besides this the resolution refers to the provision of sufficient penalties for those owners who are guilty of negligence, or for those who work a boiler without a certificate.

In declining to recommend to the Government any scheme for the compulsory inspection of boilers, the Committee has doubtless been influenced by the evidence and opinions of the large number of witnesses examined, and the majority of whom, whilst advocating strongly general inspection, deprecated Government interference, and proposed plans, most of them more or less practical, but none of which would meet all the requirements of the case.

The experience of the leading Boiler Inspection Associations militates against the conclusion of the Committee, that a large number of explosions occur from causes unpreventible by inspection. The statistics of boiler explosions show that those users who encourage periodical inspection, rarely, very rarely suffer, whilst the bulk of accidents happen to uninspected boilers. It is true that this almost total immunity from accident, on the part of the former class, cannot be ascribed entirely to inspection, for those users who adopt this precaution naturally observe all the other conditions of safety, and are, in fact, the careful class of steam users, as opposed to the other and larger class of careless owners.

The Committee, however, endeavours to get over this difficulty of compulsory inspection by throwing the entire responsibility upon the steam user, and recommending that he should be made responsible not only for himself, but for his servants, the onus of proof of efficiency both of boiler and workman resting upon him. This we consider in itself a wise conclusion: we have repeatedly in these pages called attention to the gross carelessness and the astounding ignorance that conduce so often to boiler explosions, and we have always advocated that steam users should be made responsible for any possible damage they may cause. At present it is too often the case that the unfortunate servant in charge of the boiler which explodes is saddled with all the responsibility, and takes the punishment. In some cases this is just, but in how many cases is it unjust? If the man is ignorant of his business, it is the fault of the master that he employs him. If the boiler is unreliable and unsafe, it is not the crime of the workman, who has to gain his livelihood by attending it, but that of the employer who allows it to be worked. How many men there are in the position of Lambert, who gave evidence before the Committee, and who said with reference to the boiler he looked after, "I can tell you that when the engine is working at 20 lb. I am much more happy than when she is working at 40 lb.," and who works under the settled conviction that "he should be up in the air where the boiler is, if the boiler should burst"? These opinions may, of course, be prejudiced, and his boiler may be perfectly safe, but they are the exact opinions of a large body of working men, who are compelled to undertake risks every hour of the day, and who have no means of helping themselves.

Doubtless a rigid observance of the Committee's resolution, that responsibility should be placed upon the users, would do a great deal to ameliorate the present state of affairs; for, having the fear of consequences before them, masters would naturally practise caution, and take such steps as they deemed best suited for their protection. But in doing this they would be likely to run into other dangers. We are not speaking now of the large users of steam power—the boiler aristocracy, so to speak—but of the crowd of small owners, amongst whom the greatest danger of explosion occurs. Such a legislation as that proposed would be the signal for a large number of inspecting and insuring associations to come into existence, many of which would probably be of a class totally different to the excellent ones now at work.

These might find lucrative business, but they would prove of little service to the steam user, who, lacking either judgment or prudence, places his reliance in inspectors whose ability and probity are not proved. So, then, he would continue in false security, until an explosion, and its consequent penalties, might end in ruin.

The Committee are of opinion that general inspection would be impossible without compulsion, but they appear to overlook the fact that unreliable inspectors will conduct many into the paths of penalty prepared by legislation, whilst those who take no precaution will, it is true, be punished, but not till after the mischief, that ought to have been avoided, has occurred. Prevention is in all cases better than cure. Prevention can practically be achieved by proper inspection, but proper inspection cannot be universally secured unless under compulsion; therefore, compulsory inspection ought to precede the penalties which should be inflicted under all circumstances where carelessness can be traced to the user.

With regard to the efficiency of boiler tenters employers would, if a vigorous and just legislation existed, use every precaution to obtain good men, who might be compelled to show certificates of capacity before obtaining employment. In fact, Lambert, the engine driver, in his own way, summed up the requirements very justly in our opinion, "That inspection should be compulsory, and done by the Government, and that inspectors should be appointed who should see that there were competent men employed to take charge of engines and boilers, and the same to receive a certificate that he is a competent man."

That Government inspection would be considered as oppressive by the majority of boiler users we can readily believe, but as we have before expressed our opinion, we consider that it would be the only really efficient form of inspection, if carried on under sufficiently elastic conditions. With the assistance and experience of the several able men now conducting the leading associations for the same purpose in this country, the work could be systematised, and so arranged as to interfere but little with the convenience and prejudices of steam users, in fact, to a less actual degree than would the operation of a number of independent bodies; of course the sentimental grievance against Government interference would probably be of long duration.

There can be no doubt of the value of preliminary examinations of boilers before they are put in use, the extended business of manufacturing boilers, the keen competition that exists in the trade, the desire on the part of purchasers to obtain cheap boilers, the willingness on the part of makers to accommodate their customers—all of these causes demand a thorough investigation of boilers before they leave the shop. Whether this will form a part of the new legislation on the subject remains to be seen; if it does not, there will be a serious defect in the Act; if it does, there can be no valid reason why the official inspection should not be extended further, and apply to the 100,000 boilers now under steam in this country, and the explosion of many of which, is only a question of time.

INDIAN ENGINEERING COLLEGE EXAMINATION.

THE examination which has recently taken place for the admission of students into the new Indian Civil Engineering College, deserves more than a passing notice, as it marks an epoch in engineering education in this country. The supervision of professional training in England has not hitherto been superintended and cared for by the Government to anything like the extent that prevails in other countries, but the establishment of a state college by the Indian Government shows that in their opinion the engineering education now afforded by independent institutions in this country is not conducted in a manner best adapted to insure satisfactory results. The success or otherwise of the Indian college must have its due effect upon the public works in India, and whilst we are quite in favour of the attempt now being made to improve the professional attainments of candidates for Indian engineering appointments, it cannot be denied that the experiment now being made with that object is beset with many difficulties, amongst which the opposition caused by professional jealousies and vested interests may be found not to be the least.

The general question of the establishment of a college by the Indian Government has already been so fully discussed by us, that it is not necessary now to refer further to that portion of the subject. At present we have to deal with the preliminary competitive examination for admission to the college.

This examination was conducted under the direction of the Civil Service Commissioners, at the London University, in Burlington-gardens. It extended from Tuesday the 13th June to Thursday the 22nd June, both days inclusive, the hours being from 10 to 1, and from 3 to 6 each day. The subjects comprised English composition, history, and literature, mathematics, Latin, Greek, French, and German, natural and experimental sciences, mechanical and free hand drawing. Some of these subjects were of course optional, but the most important were obligatory. In addition to the written examination, there was also an oral examination in the following subjects for those candidates who took them up, viz.: "Heat and Light," "Electricity and Magnetism," "Chemistry," and "Geology and Physical Geography."

From the foregoing brief statement of the subjects included in the examination, it will be seen that not only was it calculated to test the fitness of the candidates for their future professional training, but in order to pass in many of the subjects a very liberal prior education must have been gone through. Nor do the questions in many of the papers appear to have been confined to such as have a bearing directly or indirectly upon engineering matters. By the large introduction of non-professional subjects into these examinations, any attempt to "cram" for them, excepting perhaps in mathematics—for the obligatory portion of which only the same number of marks is allotted as is given to Latin and Greek—is most effectually prevented; but at the same time it cuts another way, for by the introduction of such a variety of subjects, two only being compulsory, viz., "English composition to the extent of a candidate's being able to write grammatically and with correct spelling," and "the following branches of mathematics, viz., arithmetic, algebra, geometry, mensuration, and plane trigonometry," it is clear that young men may obtain admission to the college who are totally unfitted by their predilections and tastes for an engineering career. Considering that up to the present year candidates for direct appointments as engineers in the Public Works Department in India have come up to the examinations often considerably below 21 years of age, whilst some have been not unfrequently as young as 18 (the limits of age for admission to the college being between 17 and 21 years), it would surely be more appropriate if the preliminary test examination for admission to the college included more subjects of a technical nature, for it is hardly to be supposed that young men of from 18 to 20 years of age who aspire to an engineering career have not, at that age, commenced their professional training. By introducing such into the examination, instead of much that we find in the papers, more good would probably have resulted than by its omission. Of what object can it have been asked, "In what plays do the following characters occur: Miranda, Demetrius, Nerissa, Autolycus, Parolles, Arthur, Jacques, &c."? or with what point was the question put as to who were the authors of Gorboduc, Polyolbion, Hydriotaphia, An Apology for Smectymnus, The Parish Register, Areopagitica, Hermes, Mother Hubberd's Tale, and other works?

But if we are unable altogether to approve of the paper on English history and literature, the one on physical geography and geology is of a sound practical nature. Arithmetic, including mensuration and algebra, are briefly disposed of in fifteen questions, which, we submit, are far too few fully to test the knowledge of the candidates in those subjects. Geometry and trigonometry constitute another short paper, whilst pure and mixed mathematics have each a paper of twelve questions allotted to them. Chemistry, light and heat, and electricity and magnetism have each a short paper allotted to them, which were each allowed to occupy the candidates for three hours. Geometrical drawing is, of course, an important qualification for an engineer, and it appears to have been so treated by the examiners, for one whole day was given to the subject, and the questions requiring drawings for their solution were twenty in number. Free-hand drawing, also a most important qualification, occupied another whole day, the morning having been devoted to minor subjects, whilst the whole afternoon was given up to making as complete a drawing as possible from subjects put before the candidates for that purpose. The examination commenced, of course, with the obligatory subjects in the following order: Arithmetic, mensuration, and algebra, geometry and trigonometry, dictation and English composition, English history and literature. Then followed pure and mixed mathematics, languages, and the optional subjects, and finally geometrical and free-hand drawing, the whole occupying nine complete days.

This was in the strictest sense a competitive, but not a test, examination, for in accordance with the terms of the college prospectus the fifty who were highest on the list were to become entitled to admission irrespective of any standard of excellence excepting in the obligatory subjects, and fifty candidates have accordingly been selected for the college. Altogether 220 candidates presented themselves for the examination, of whom, however, 108 failed to pass a qualifying examination in one or both of the two prescribed subjects, and were not, therefore, allowed to proceed with their examination. The numbers who thus presented themselves for admission to the Indian Engineering College must prove very gratifying to its promoters, as it gives most conclusively a flat contradiction to those who delighted to predict its failure for want of support, as well as to those who argued that such an institution was not required, for it has been seen that no less than 220 desired to enter it with the view of obtaining a professional education, and an equal number of parents have presented themselves willing to bear the necessary expenses of their sons' training there, and so giving a most satisfactory reply to those who consider the terms fixed by Government too high for general support. Thus far, it may be safely concluded that the results of the preliminary competitive examination have fully justified the course adopted by the Indian Government in establishing for themselves an engineering college, and we sincerely hope that subsequent results may prove equally satisfactory.

PRACTICAL ELECTRICITY.

M. ERNEST SAINT-EDME, Examiner in Physics at the Conservatoire des Arts et Métiers, and Professor of Physical Sciences, has just published an interesting volume on the application of electricity to the mechanical arts, in the navy, and in the theatres. Naturally he studies the sources of electricity, the apparatus employed, and all the various practical applications.

Amongst the sources of electricity, those most employed are galvanic elements; there exist of these a great variety, and it is difficult to say in which the inventor's ability has been most exercised. They are divided into two classes: those of great intensity and short duration; those of small intensity and of long duration. Among the first we may mention the bichromate of potassium element. In one series of vessels containing a solution of the bichromate, and one hundredth part of anhydrous sulphuric acid, there is placed the necessary pair of plates, each formed of a plate of zinc, and two plates of charcoal; these are lifted out of the acid when the current is not required. This element, which produces a current of great intensity, is especially used in the service of exploding mines, or in surgical operations. In constant current batteries, the efforts of investigators direct themselves towards the suppression of porous vessels, the resistance of which, considerable when they are put in action, is much increased by the action of saline and metallic crystals.

In the element of M. Callaud, sulphate of copper and acidulated water are placed in the same vessel, and superimpose themselves in the order of their density. This battery cannot be moved about, but once installed in a fixed position, it gives a current of a very constant intensity. M. Minotti places in the same jar a disc of copper, then a layer of sulphate of copper in powder, then a bed of pure sand, supporting the zinc plate. When water is placed in the jar, the action of the element begins, and its intensity remains constant so long as the loss of water through evaporation is replaced.

The sulphate of mercury battery of M. Marié-Davy, used in the telegraph service during several years, has been abandoned, and a return has been made to the sulphate of copper battery, in non-porous jars. M. Grenet has for some time applied successfully to bell-ringing apparatus a sulphate of mercury battery with a non-porous vase.

In the Léclanché battery, the carbon is surrounded with a mixture of peroxide of magnesia and of graphite, and which contains a solution of chlorhydrate of ammonia. Although the official telegraph administration has not adopted this apparatus, it has, nevertheless, come into favour in a large number of applications.

M. Warren de la Rue employs couples formed of a zinc plate, and of chloride of silver, contained in flasks of hard rubber, filled with saline water, and hermetically sealed.

M. Gaiffe has applied a new battery to his electro-medical apparatus. Two couples are sufficient to obtain, during 24 hours, fifty times the force of one nitric acid element.

Electro-magnetic machinery has received extraordinary improvements since the first arrangements of Clarke or of Pixii. We may mention the Gaiffe machine, the Henley magneto-electric key, the Siemens magnetic coil, and the electro-magnetic machines of M. Noillet, employed in France under the name of the Alliance machine, which is especially applied in the production of the electric light.

The thermo-electric piles, which have remained much the same since 1821, do not enter into the industrial domains. M. Becquerel forms each element from a plate of sulphuret of copper and a plate of German silver, composed of copper, of zinc, and of nickel. The pile is heated by a gas jet. Thirty such elements suffice to decompose water, to heat a platinum wire to redness, and to excite an electro-magnet. Each element is equal to about a quarter of a Daniel's element. MM. Morre and Clamont replace the sulphuret of copper by sulphuret of lead, whose electro-motive force is greater, and gives to the battery a more favourable power for utilising the heat. All the inventions, however, of this class seem to represent but little progress in the delicate question of transforming heat into electricity.

The dynamic condenser of M. Garton Planté is a curious and important invention. It permits, so to speak, of an accumulation of the powers of a battery of two or three elements, until a discharge equal to the force of fifty or sixty is obtained. In a jar made with lateral grooves are arranged vertically a series of parallel lead plates, very close to each other, and perfectly insulated. One series of pairs of plates are connected, and put into connexion with one of the poles furnishing the current. The same is done with the other series. The jar is filled with acidulated water. The current of the battery decomposes the water gradually, accumulating hydrogen on one group of plates, and oxygen on the other. If the two groups of plates are put into communication, the oxygen and hydrogen combine afresh, and produce a current of great intensity. The action of the apparatus may thus be indefinitely maintained. This condenser is employed almost exclusively in surgery.

Many applications have been made of electricity as a motive power: it is employed for driving sewing machines, in spinning factories, in railway brakes, &c., but it is especially in the transmission of indications that this power finds its most useful application. It is employed to send from a distance thermometrical and barometrical observations, to indicate the presence of gas or fire-damp in mines, in some German towns, and also at Menton, near Nice, it is used to avoid premature inhumation.

After a rapid review of overland, underground, and submarine telegraphs, M. Saint-Edme takes up the consideration of the practical application of electricity to the marine. The protection of ships' plates and armour has been made the subject of special study by M. Becquerel at the port of Toulon. He has determined the electro-motive force of the metals and thin alloys entering into the construction of ships' plates, as compared with that of zinc, and has learnt what extent of surface of iron or copper a plate of zinc of given dimensions can protect.

Of electric lamps, those of Foucault and of Serrin, supplied by an electro-magnetic apparatus, are employed for night signals on board ship, and for illuminating lighthouses. During the last war the principal French ironclads and gunboats were furnished with electric lanterns. By the help of this light, entry into port by night was possible, as well as manœuvres in the dark amongst crowded shipping. The same lamps can also be employed under water for submarine exploration.

Torpedoes have, of course, become a most important element of coast and harbour defence. To explode them the induction coil, with the Brequet

exploder, is often employed, in which a current is generated by removing suddenly from the magnet its soft iron armature. The explosion is produced by the help of the Ebner fuses, in which the spark strikes a mixture of chlorate of potassium, of sulphuret of antimony, and of charcoal, or by Abel fuses. By this apparatus explosions can be produced at distances of two or three hundred miles.

In the theatres for several years electricity has been employed for the transmission of signals, to give the time to musicians placed out of sight of the musical conductor, and by the help of the apparatus of M. Duboscq, to light up any given part of the stage. M. Saint-Edme gives some interesting details of this latter application. He describes the means for obtaining rainbows, lightning, and illuminated fountains. He describes, also, the employment of magnesium and other lights, and the production of spectral and phosphorescent phenomena. Electricity gives very beautiful phosphoric effects well known in physics by the Geissler tubes. These are utilised in the theatres in a variety of forms; for example, they are employed in the illuminations of diadems and other insignia, in transformation scenes, and in the imitation of fireworks.

Thus each day the practical application of electricity is extending, and for further information we refer our readers to the book of M. Saint-Edme, from which we have compiled the foregoing facts in preference to making a formal review of the work.

SHOEBURYNESS EXPERIMENTS.

AN interesting series of experiments was carried out at Shoeburyness on Wednesday last, upon which occasion the capabilities of a new target, designed by the War Office authorities, and the Prussian field gun recently presented to this country, were tested. The target is of unusually large size, measuring 48 ft. long by 9 ft. high. Although built up in one, it really represents two systems of targets. In one the armour plating is 8 in. thick, with a backing of teak 18 in. thick and a $\frac{3}{8}$ in. iron skin with iron ribs in the rear. In the other the front plate is 8 in. thick, and is backed by 5½ in. of teak, behind which is a 5 in. armour plate backed with 6 in. of teak and a 1½ in. iron skin. The guns brought to bear upon this compound target were the 9-in. Woolwich muzzle-loading rifled 250-pounder, and the 11-in. Woolwich muzzle-loader rifled 500-pounder gun. The 9-in. gun was directed against the 8 in. armoured portion, and the 11-in. gun was laid against the target carrying the 13 in. of divided armour, the ranges being in both cases 200 yards. Both guns penetrated the targets, the 11-in. weapon doing exceptionally good work in sending its projectiles through the two armour plates and backing of the second target. Both plates were cleanly penetrated, the puncture disclosing the fact that the metal was of splendid quality. The second part of the programme for the day consisted of comparative trials with the nominal 4-pounder breechloading Prussian rifled field gun, fired with 9 lb. cylindrical projectiles, against the English muzzle-loading 9-pounder and 16-pounder field guns. The general results of this practice were that the English 16-pounder fired 25 rounds in 13 minutes 30 seconds, making 14 hits upon the target; the English 9-pounder fired the same number of rounds in 8 minutes 37 seconds, scoring 13 hits, whilst the Prussian field gun fired a like number of rounds in 10 minutes 15 seconds, making 13 hits. Competitive practice was then carried out with the three guns against targets representing troops with good results. We defer our detailed report of the proceedings in order that we may accompany it with engravings of the new target.

PLASTER OF PARIS MANUFACTURE.

THE quarrying of gypsum and the manufacture of plaster are important industries in Paris, and we have recently taken the opportunity of visiting one of the establishments of this kind, the best arranged, that of M. Morel, at Montreuil. The plaster of paris, or gypsum, consists, as is well known, of hydrated sulphate of lime. The water being removed by roasting, the stone is ground into powder. When this is afterwards mixed with water, it combines itself again, and forms a solid mass, which is employed in an infinite variety of ways. The abundance of gypsum at Montmartre, Pantin, Menilmontant, Belleville, Charonne, Montreuil, &c., all close to Paris, even within the city limits, the good quality of, and the large demand for the plaster, and the ease with which it is employed, have caused the development of this great industry in the capital. The plaster of paris has a European, and even a still more extended reputation. It is employed everywhere, and is put to the most varied uses. It is moulded into hollow bricks, and tubular blocks, in building up partitions and walls, for paving slabs, and for smoke conduits to chimneys. One sees even in the neighbourhood of the quarries, houses, of three and four storeys, which are built in moulded stones of plaster, or made in plaster in such a manner that they form a monolith.

The bed of gypsum worked at Pantin is horizontal: it has a thickness of 37 ft. 2 in. There is also a small bed adjacent, and of little thickness, but this is not quarried as a rule. The gypsum of this bed is almost entirely crystallised, and there are found there, in abundance, those beautiful specimens called *fers de lance*, on account of their form. These fragments split with ease into thin transparent leaves, and when the apparent limit of divisibility has been formed with the blade of a knife, if one takes one of the leaves, which has less than $\frac{1}{10}$ in. of thickness, and heats it, it exfoliates into more than twenty films, as the water it contains is heated and disengages itself in steam.

The bed of gypsum that is excavated is covered by some 40 ft. of earth, consisting of calcareous deposits, and marl and clay. It is excavated, for the most part, by subterranean galleries, but it is sometimes found more economical to work from the surface, in spite of the great thickness of superincumbent earth, because there are numerous situations where the excavated material employed to fill elsewhere can be made a source of revenue, while the limestone can be sold to make lime, and the clay to make earthenware, or bricks.

It is thus that the quarry of Eprisette, worked at first in galleries by M. Morel, is changed at the present time into open excavation.

The gypsum is extracted by blasting. Holes are pierced in the rock, which, for the most part, is sufficiently soft for a workman to drive in less than an hour a hole from 4 ft. 6 in. to 6 ft. deep and .2 ft. in diameter. After a blast, the rock is struck with crowbars, which divides it into blocks from 30 to 40 metres cube, advantage being taken of the numerous faults in the material, which the workmen learn to recognise at a glance, and which they call "*maillances*." A heavy blow, or the introduction of a pick, at the right spot, divides easily the largest blocks into convenient fragments.

These fragments are loaded upon trolleys, which follow the face of the gallery or cutting on tramways, and which lead up to the eight furnaces composing the factory. These kilns, or furnaces, are of the simplest form. They consist of an end wall 15 ft. long, and of two side walls of the same length. The three walls are also 15 ft. high, and the square hearth that they surround, carries perpendicularly to the end wall, five gratings, through which passes the air necessary for combustion. On the ground, the largest blocks of gypsum are arranged, in such a manner as to construct above these gratings arches sufficiently high to receive the fuel for burning the material. The spaces intervening are filled up with other fragments of rock, more of which is added from above, so that the height of the mass is raised. When the greatest height conveniently attainable by hand is reached, the charging of the kiln is continued from trolleys brought upon inclined plans which are also supplied with rails. This is carried on until the height of the charge is equal to that of the walls of the kiln. All the interstices are then carefully packed with small fragments of the stone, and the front of the furnace, which is raised by a low wall, receives a movable cover of plate iron intended to prevent the loss of heat by radiation; and to retain such morsels of stone as become detached during the operation of baking; the joints in the front of the kiln are luted.

Everything being then prepared, fagots are placed within the arches and lighted, and when the embers are in full glow and the arches half empty, they are charged with briquettes of artificial fuel, and the fire is so managed by regulating the access of air, that the baking of the mass is effected equally throughout without any extremes of excessive or imperfect burning. The operation is complete in 24 hours.

The employment of briquettes is one of the improvements introduced by M. Morel into his establishment. The baking was generally done with wood, and the substitution of coal has effected a saving of two-thirds of the total quantity produced. There is but a comparatively small loss of heat in this apparatus, so simple and apparently so primitive. In calculating the calorific power of the quantity of fuel consumed, and the amount of heat necessary to evaporate all the water contained in the gypsum; it is found that he utilises one-half of the available heat which is certainly a satisfactory result, considering all the various losses inseparable from an identical enterprise.

After the calcination is complete, the furnace is allowed to cool, and the burnt gypsum is again loaded into wagons and carried off on the tramway to the grinding mills. This part of the manufacture consists of two parts. There are the mill stones in cast iron or stone, banded with rings of iron and turning in a circular trough with a grated bottom. The calcined stone is fed into the mill, and those parts which are ground down extremely fine pass through its gratings. The rest is removed by a suitable mechanical appliance for grinding.

One of the mills carries a most ingenious arrangement for screening the fine powder. Below the grate there is a strainer in the form of a truncated cone. Of the powder which falls upon this strainer through the base of the annular grate, a part passes through the meshes and escapes through the lower part of the apparatus, the rest slides on the conical strainer falling on a table at the bottom, and is constantly lifted by a chain and replaced on the table of the mill. After the powder is sufficiently ground it is conveyed below into a storehouse where it is placed in bags. The mills are driven by a 12 horse steam engine.

The whole of this establishment is ably arranged and managed, from the quarries to the plaster depôt, and the working out of all the practical details does honour to the able proprietor who created them, and who still works daily to improve them.

LITERATURE.

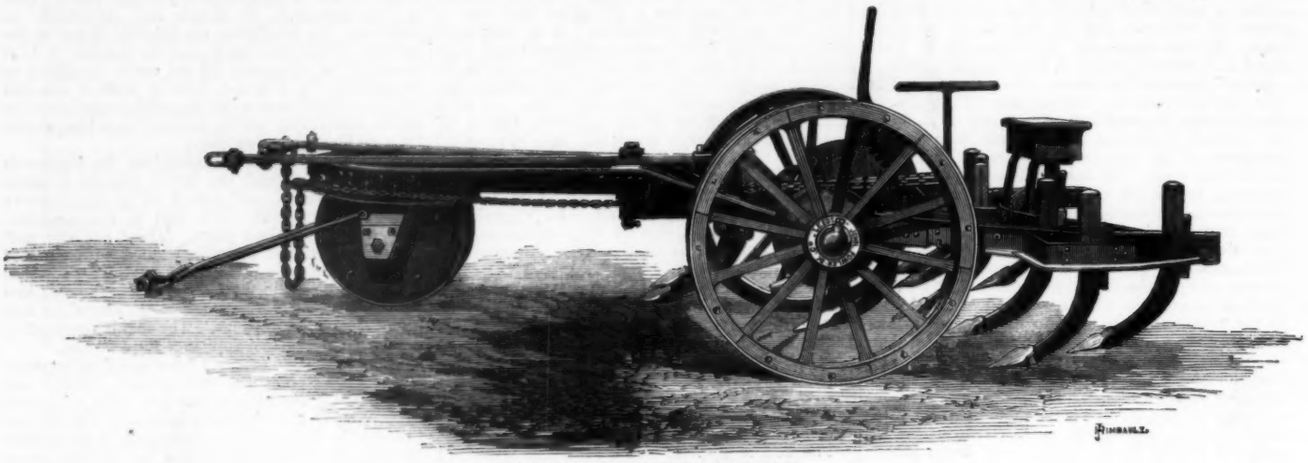
Model Drawing, containing the Elementary Principles of Drawing from solid form, the Method of Shading, and Pattern for making Drawing Objects in Cardboard. By ELLIS A. DAVIDSON. London: Cassell, Petter, and Galpin, 1871.

THIS is another little volume belonging to the series which Mr. E. A. Davidson has from time to time written, and which Messrs. Cassell, Petter, and Galpin have published. The previous volumes we have noticed as they appeared, and the same favourable criticism awarded to the previous volumes may be extended also to this. It is specially intended to accompany a series of models of different elementary forms by the aid of which an almost infinite variety of lessons may be given to the student, and the book, which, however, may be equally well studied without the models aforesaid, and which, by the way, seem to be unnecessarily costly, contain also practical directions to the student for enabling him to construct models for himself out of cardboard. As with the previous books, the present is divided into a number of simple problems, each of which is progressive, and is fully and clearly demonstrated and worked out. The combination of cubes, cylinders, cones, &c., afford a most excellent means of instructing the pupil, not only in geometrical, but also in perspective drawing, and though Mr. Davidson's book is full of useful information, it but indicates a small proportion of what may be done by the aid of the models.

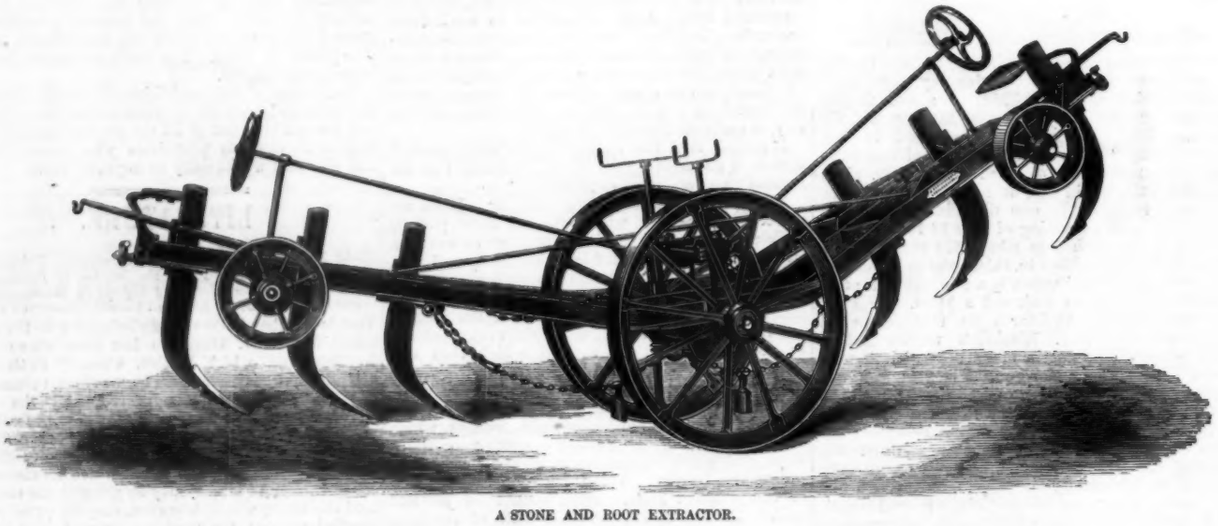
Mr. Davidson is a thoroughly good teacher, moreover, he is able to place his instructions clearly and plainly upon paper, and the youngest and most inexperienced of his students cannot fail to realise the full amount of benefit from this book. We recommend it to all would-be draughtsmen; its price, three shillings, places it within the reach of all, and taken in conjunction with the rest of the series, cannot fail to be a most valuable addition to the student's library. We suppose it will be followed by others upon the projection of shadows, &c.

NARROW GAUGE LOCOMOTIVE.—The first light (3 ft. gauge) locomotive used in Missouri, was built by A. C. Robertson, of St. Louis Iron and Machine Works. He built the first regular locomotive in the West, in 1855, and has now just completed the first narrow-gauge locomotive. This engine weighs about 6 tons on the road, and is expected to draw 100 tons on a level, and 30 to 40 tons on ordinary grades. It has two 7×12 in. cylinders, an 8 ft. 8 in. boiler, and sixty-two 2 in. tubes. The tank will hold 156 gallons of water. The engine is also provided with the link motion, and is furnished with a substantial and handsome cab.

THE WOLVERHAMPTON SHOW; MESSRS. J. FOWLER AND CO.'S EXHIBITS.



ELEVEN-TINED TURNING CULTIVATOR.



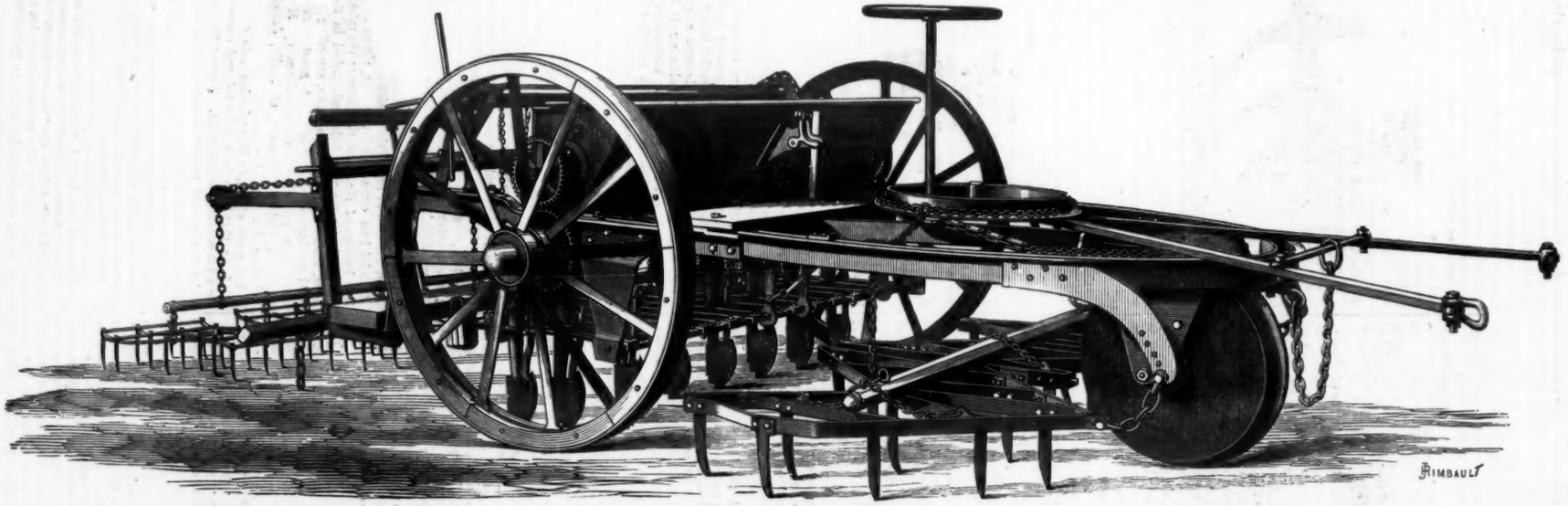
A STONE AND ROOT EXTRACTOR.

15 FT. STEAM HARROW

TURKISH TORPEDOES.—Two kinds of torpedoes—offensive and defensive—have been devised for use in the Bosphorus. The defensive torpedo consists of a strong wrought-iron tank capable of containing about 4 cwt. of powder and lying at the bottom of the water. From a fuse in the interior proceeds an electric cable containing a double wire and communicating with a voltaic battery on shore. The tank is also provided with an index which floats within 5 ft. or 6 ft. of the surface of the water and which, on being touched by the bottom of a ship, immediately conveys a signal to the shore whence an electric spark would be sent through the powder in the tank, the explosion either sinking or disabling the ship above it. The offensive torpedo is intended for attacking under cover of a dark night enemies' ships lying at anchor, and it consists of a hollow iron pear-shaped vessel containing a heavy charge of powder and provided with several percussion fuzes. This kind of torpedo is fixed to the end of a boom some 30 ft. long, which is attached to the head of a small steam launch specially constructed for the purpose. To the boom, which hinges on the head of the vessel is attached a chain which runs in board over a pulley and which can be shortened or lengthened at pleasure, raising or lowering the torpedo in the water. The upper portion of the torpedo case is provided with five percussion fuzes, one of which is certain to strike a ship's bottom when propelled against it.

COAL IN SPAIN.—The Spanish *Credit Mobilier* is interested in the working of the Barruelo coal mines. The profit derived from working declined, however, from 11,614*l.* in 1869 to 9022*l.* in 1870, in consequence of the competition on the Madrid market of English coal, and coal obtained from new mines in the interior of Spain.

THE WOLVERHAMPTON SHOW; EXHIBITS BY MESSRS. J. FOWLER AND CO.



COMBINED DRILL AND HARROWS FOR STEAM CULTIVATION.

FRENCH OCEAN STEAM NAVIGATION.—The accounts of the French General Transatlantic Steam Navigation Company for 1870 show a net profit of 221,879*l.* No dividend can be paid, however, at present upon the shares for the past year.

UNITED STATES' RAILWAYS.—According to Mr. Poor's American *Railroad Manual* for 1871-2, just published, there were in operation in the United States on the 1st of January, 1871, 53,145 miles of railroad, of which 6145 were opened in the past year, a greater number than in any previous year by 2600 miles. The total earnings of these roads during the past year were 450,000,000 dols. The gross tonnage transported over them equalled 125,000,000 tons, having a value of more than 10,000,000,000 dols. Their cost may be put down, in round numbers, at 2,400,000,000 dols. Their mileage, in ratio to the population of the country, is as 1 to 723. Their earnings equal 11 dols. 75 cents to each inhabitant. The tonnage transported equalled 3¼ tons to each; the value of this tonnage equalled 282 dols. to each. "All this vast tonnage and commerce," Mr. Poor remarks, "has been wholly created by the reduction effected in the cost of transportation. The cost, for example, of transporting a ton of Indian corn or wheat over ordinary highways will equal 20 cents per mile. At such a rate the former will bear transportation only 125 miles to market, where its value is 75 cents per bushel; the latter only 250 miles, where its value is 1 dol. 50 cents per bushel. With such highways only, the most valuable of our cereals will have no commercial value outside of circles having radii of 125 and 250 miles respectively. Upon railroads, the cost of transporting these articles equals only 1¼ cents per ton per mile. With these works, consequently, the areas within which corn and wheat will have a commercial value, will be drawn upon radii of 1600 and 3200 miles respectively. The area of a circle having a radius of 125 miles is 49,087 square miles, that of a circle drawn on a radius of 1600 miles is 160 times greater, or 8,042,406 square miles.

THREE-WHEELED WAGON.

GREENOCK HARBOUR.—The foundation stone of a new graving dock was laid at Greenock on Thursday, with Masonic honours. The site of the undertaking is in Garvel Park, and has cost 80,000*l.* The dock, with pumping machinery and caisson complete, will cost 50,000*l.*, and the temporary and outer works 18,000*l.* The contract is expected to be completed by the spring of next year. Although in the meantime entering directly to the fairway of the river by a dredged channel, it is intended that the new dock shall form part of a system, eventually opening into a tidal harbour of some magnitude. As showing the rapid increase of the shipping traffic at this port, Provost Grieve mentioned, at a dinner given in honour of the day's proceedings, that the harbour revenue in 1836 was 11,637*l.*, in 1861, 25,000*l.*, and this year was estimated to be 53,000*l.*

THE TRACTION ENGINE ABROAD.—It is painful to hear that an English road engine has been misbehaving itself in a foreign country, yet this appears to have been the case in Macedonia. A correspondent of the *Levant Herald*, writing from Salonica on the 20th ult., says that "great things were expected of the road engine, but as yet, unfortunately, without being realised." The Pasha gave it every advantage, he had a roadway of a very gentle gradient constructed for it between the pier and some unsightly mounds of refuse which for many ages have accumulated outside the city gates. It has somewhat lessened these mounds, but ere this it ought to have cleared them away had it been in an efficient state. However, it never worked well, its steam was soon exhausted, and it continually required repairs. Latterly it broke down altogether, and on being examined the boiler has been found to have been made of old materials utterly unfit for the purpose. It is curious to observe that after the lapse of many ages retribution has fallen on the Greeks for their conduct at the siege of Troy. They deceived the Trojans with a wooden horse, and are now themselves taken in by a road engine.—*Pall Mall Gazette.*

NOTES FROM PARIS.

PARIS, July 10, 1871.

MINES.

MINING and metallurgical industries are resuming their wonted activity throughout the country. The best intelligence on this subject comes from the Haute Marne, from the Meurthe, the Moselle, and the Nord departments. The transports of coal and iron are limited only by the amount of railway stock available. The Eastern Railway Company in particular have failed in obtaining a restitution from the Germans of thousands of wagons belonging to the line, and it is easily imagined how much this present state of things affects industry.

RAILWAY ACCIDENTS.

Again, this week there has been a serious railway accident. A mail train on the Paris, Lyons, and Mediterranean line was thrown off the rails, on the morning of the 2nd of July at Pontmort near Clermont: the official statement of the company shows six people killed, and twenty injured.

VENTILATION OF BUILDINGS.

General Morin has contributed an essay to the Academy containing facts relating to the ventilation of the palace of the Corps Législatif during the year 1869-70. Complaints had been made of the general occurrence of injurious draughts of air without an effective renewal of the air in the building. The doors of the sessions chamber are of course very frequently opened and closed, and it is necessary, in order to avoid the air currents, to adopt a general system of warming and ventilation, which should certainly insure a uniformity of temperature, and a regular renewal of air, in the chambers, the staircases, and the corridors. Collectively the amount to be heated and ventilated is more than 20,000 cube metres. It is proposed to obtain in all the parts of the building an equality of temperature, and a regular change of the air every forty minutes. The sessions chamber will contain about 1000 persons, and the quantity of air to be furnished per hour was fixed at 30,000 cube metres for the principal salle, and 15,000 cube metres for the other chambers, &c. The temperature decided upon is 68 deg. Fahr. as a mean to be maintained in the principal chamber during the cold season. The committee appointed to report upon the question, having decided upon the data, gave the preference to the use of perforated bricks for admitting the heated air, and resolved to get rid of the vitiated air in the great chamber through openings in the steps and through the lower panels of the doors, and for all the other parts of the building through openings in the floor. The fresh air is admitted into the great chamber above the circular cornice, as well as through the ceiling in the great chamber, and through the glazed ceiling in two other large salles.

The works having been executed in conformity with this programme, a series of observations were proceeded with to ascertain if the means adopted were satisfactory. Forty thermometers were placed in the building, and records were made, from which the following facts were established:

1. That during the season for warming the building the temperature of the large and smaller chambers was sensibly uniform and constant, being at the commencement of a séance about 64.40 deg. Fahr., and at the close from 66.20 to 68 deg.

2. That during the time of low temperature, and in winter and spring, the temperature of the air admitted having been regulated from 66.20 to 68 deg., that of the salle only averaged 64.40 deg., rising from 69.80 to 71.60 deg. during the most crowded sittings.

3. That in the summer the chamber was maintained from 64.40 deg.; at the commencement to 76 deg. at the close of a séance.

4. That during the hottest days when the outside temperature reached 82.40 deg., the interior of the palace was from 5.40 to 9 deg. cooler.

It has been observed that during the summer the underground conduits through which the air is brought cooled it down to such an extent that it was too cold to be passed into the chambers, and that a slight warming was necessary to avoid inconvenience. With the same object a little of the cool air is sometimes mingled with the air taken from the upper parts of the building.

The uptake shaft had to be heated to a greater extent in summer than in winter, in order to insure a ventilation sufficiently active to produce a sufficient lowering of temperature.

The problem of the objectionable air currents has been one more difficult of solution, and the report of General Morin alludes to the physical susceptibilities of many of the deputies who found easy grounds for complaint. But frequent observations with the anemometer, and with wax candles, showed that equilibrium was well sustained, and that the renewal of air had attained moreover a higher value than had been wished. When indeed it remained considerably below the average amount the ventilation was sufficient to prevent the closeness attendant on a crowded audience.

The means of ventilation established were at first too powerful; it was necessary to check them, and the 2½ renewals of air per hour were too much for the convenience of the members, and the amount was reduced from 14 to 15 thousand cube metres per hour. It is sufficient to regulate the ventilation by manipulating the register arranged for this purpose. By these means a perfect regularity is obtained. During the spring and summer the cube metre of air entering the building has been raised from 18 to 20 thousand metres per hour; this was done in order to suit the susceptibilities of the various persons attending the salle.

Electrical indicator apparatus are placed in a small chamber on the ground floor, in which are also placed the means of regulating the registers, so that one attendant can regulate the temperature according to necessity in any part of the palace.

LOCOMOTIVE IMPROVEMENTS.

During the last few years the engineers of French railways have been studying various types of powerful locomotives, suitable for the economical transport of heavy mineral trains, or of trains intended specially for the working of secondary lines.

M. J. T. Meyer, of Mulhouse, the inventor of the expansion gear that bears his name, is just now calling the attention of engineers to the system of locomotives, which he studied some years since in connexion with his son, M. A. Meyer. The following is the problem the inventors addressed themselves to solve: To construct a type of locomotive of a maximum power, carrying its own water and coal, having the least possible weight in relation to its heating surface, carried upon so many axles that the weight upon each pair of wheels may be reduced to a minimum, in order to reduce the rail section of the permanent way; to utilise the whole weight for adhesion, without, however, having more than six wheels coupled in such a manner as to give every facility for accommodating themselves to rapid curves upon the road. The solution of this problem is obtained by dividing the machine into two groups, independent of each other, and of the single boiler which supplies them with steam. The boiler can thus be made, without giving any instability, of dimensions suitable for a good utilisation of fuel, even of an inferior quality, and of an abundant production of steam. Such a locomotive is able to draw heavy loads at a fair speed without distress to to the rails, and thus it is possible to construct and work local lines with steep gradients, sharp curves, and very light rails.

The single boiler is supported on two independent frames, but coupled one to the other by a bar. Each frame is mounted upon at least two pairs of wheels, sometimes three pairs are employed and exceptionally four; each frame carries its own motor. The boiler rests on the forward frame by a vertical pin placed almost in the centre of the frame; and upon the after carriage by means of two sliding blocks. The coupling bar has for a forward turning point the bearings of the pivot upon the forward frame, and is jointed to the rear frame in its centre of gravity. Either one or both of the pairs of cylinders can be worked according to the work which the engine has to do. The admission of steam to the cylinders is effected by means of long flexible pipes.

MM. Meyer have embodied the foregoing details: 1st in a high speed engine in which each frame carries two pairs of driving and two pairs of bearing wheels; 2nd, in an engine made with two independent frames, each with six wheels of which four are coupled; 3rd, in a goods engine with six wheels coupled in each frame, and, 4th, in two types of engines for light lines with small traffic, the one with two sets of four coupled-wheels the other with two sets of six wheels. These engineers built a tank engine with two frames with four coupled-wheels which was submitted to various trials on the lines of the Northern Railway at the end of 1869, and the commencement of 1870. The following are the particulars of one of their engines called "L'Avenir": the boiler is in steel with the exception of the firebox which is of copper. The forward pin of the underframe is of cast steel, working in brass bearings, the frame and the rods of the motions are of steel; the wheel tyres are of Krupp steel. The boiler is fed by a feed pump and an injector. There are two regulating levers and a screw reversing gear, and steam can be admitted, or cut-off from each pair of cylinders. The Walschaert's valve gear is employed. The exhaust is annular. Several means of braking are employed, there are a hand brake, a steam brake, and a Le Chatelier brake. The principal dimensions are as follows:

Area of firegrate	18.183 sq. ft.
Number of tubes	200
Length of tubes	15 ft. 10$\frac{1}{16}$ in.
Total heating surface	1678 sq. ft.
Diameter of cylinder	13$\frac{3}{4}$ in.
Stroke of cylinder	21$\frac{5}{8}$ in.
Diameter of wheels	4 ft. 3$\frac{7}{16}$ in.
Distance apart of wheels of each frame	9 ft. 6$\frac{5}{8}$ in.
Extreme wheel base	19 ft. $\frac{3}{4}$ in.

The first experiments that were made took place between Lens and Arras on a line with gradients of 1 in 200. The engine drew 46 wagons weighing 645 tons, at a speed of about 13 miles an hour. Afterwards on the line of St. Gobain with maximum gradients of 1 in 55, and curves with a radius of about 900 ft., this engine was in regular working for some little time. There was found no difficulty in taking the engine round 260 ft. curves, and up slopes of 1 in 42. Lastly this engine of MM. Meyer was put into service at Paris on the Northern Railway, and it furnished on the lines of Amiens, of Lerguier, and of Soissons, a duty of about 6250 miles during the last three months of 1870. The consumption of compressed fuel per train mile was 58.8 lb., an amount rather in excess of coal consumed by ordinary engines doing the same duty.

In their last report MM. Meyer seek to establish by calculation the influence of twelve coupled-wheeled engines on their system in the working of railroads. On their showing the economy in engine expenses would be 28 per cent. as compared with six wheeled engines, and 24 per cent. as compared with eight wheeled tank engines. These economies would allow for a reduction of the capital now required for locomotives, a reduction of staff expenses, a less consumption of fuel, and a reduction of cost in maintenance and repairs. In spite of the amount of uncertainty which surrounds calculations of this kind, it is, nevertheless, established that we can employ the powerful engines with twelve wheels; and the first tests to which the "Avenir" was submitted have encouraged the efforts of the inventors and merit the attention of railway companies.

It must not, however, be forgotten that the problem MM. Meyer have been working out had long before been demonstrated by Mr. Fairlie, and that the results he has attained are as much more perfect, as his engine is more perfect than that of MM. Meyer. In fact, these gentlemen are some years behind Mr. Fairlie, who has fully demonstrated the capabilities of the system he introduced eight years ago.

ELECTRO-MAGNETS.

With tranquillity, books appear; we notice one just published. M. le Comte Th. du Moncel has just issued the result of his inquiries into the best conditions of construction of electro-magnets. The numerous and important applications which these apparatus now receive, give to this book a great practical interest, whilst the involved problems of physical mathematics investigated by the learned author will prove attractive to theorists. It is not sufficient to obtain from a distance a practically useful electric action, to have a source of electricity and a circuit, it is necessary to have an auxiliary to transform by a material action, the effect of the momentary circulation of the current of the circuit. This auxiliary is the electro-magnet. Since the discovery of Ampire and Arago, of wrapping wire helically around a core of iron, the construction of electro-magnets has been made the object of study by many able men. Mr. Morse appears to have been the first who placed the electro-magnet in a conspicuous position in electricity. But it was MM. Lentz and Jacobi, celebrated Russian savants, who by numerous experiments, and by mathematical investigation, established the first rules of construction. They showed, first, the form of the electro-magnet is proportioned to the intensity of the current, and to the number of the conducting wires; second, that to place the electro-magnet in the best possible conditions in relation to the circuit in which they are interposed, it is necessary that the resistance of the coil should be equal to that of the part of the circuit foreign to the magnet.

A little later Mr. Wheatstone, applying these deductions to telegraphy, changed completely the conditions of their construction, in making them of small dimensions, and employing fine wire. In this manner he obtained excellent results. But these two laws led to the result, that a very small mass of iron could become a source of indestructible force. M. Müller believing in the impossibility of such a result, undertook numerous experiments, which led him to discover that not only is a mass of iron susceptible of a certain maximum amount of magnetism, but also that the law of Lentz and Jacobi is only true within certain limits of the magnetic condition of iron, and that even between these limits, the force of the electro-magnet is proportional to the square roots of the diameter of the magnetic cores. M. Dub showed by other experiments that the force is also proportional to the square roots of the lengths, and as the attraction which results from this force, decreases in proportion to the square root of the distance from the middle point of the magnetic core to the armature, it follows that the two laws of Dub and Müller combined, can be summed up by the following proposition: The attractive force of the electro-magnet on an armature is proportional to the diameter of the magnetic cores, and to the square roots of their length.

Lastly, M. du Moncel showed that he had in the electro-magnet a kind of magnetic condensation; he also replaced the solid iron cores with iron tubes, closed at the poles by iron buttons of the same thickness as the tube. The laws ruling electro-magnets being established in their simplest form, modifications of these laws, according to their practical application, were sought. A great number of works have been published on the subject by MM. Nicklés, Cecci, of Florence, Siemens, of Berlin, Jocelle, Hughes, Robinson, &c.

The work of M. du Moncel takes into consideration all the facts that have been collected, and corroborates them by mathematical investigation. Among the conclusions to which the learned author is conducted by calculation, we will mention the following.

To realise the maximum force in the case of a circuit perfectly insulated, and of an electro-magnet at the point of saturation, the coil should have a thickness equal to the diameter of the core, and a resistance double that of the exterior circuit. The length of each arm should be equal to six times the diameter, and the traverse, as well as the armature, should have a length equal to that of the arms. Lastly, the armature should be prismatic and articulated, with a thickness a little less than one-fourth the diameter, placed with the flat side towards the poles. When the circuit is not completely insulated, or in the hypothesis of an inferior magnetic condition to that which corresponds to the point of saturation, these conditions are modified.

There will be found in the work of M. du Moncel all the necessary formulæ for determining the dimensions of an electro-magnet, the length of wire, &c., in such a manner as to correspond with an exterior circuit of given resistance. The book will be valuable to all telegraph engineers, as well as for makers of electro-magnetic apparatus; they will find there, amongst other new matter, the explanation of the properties of electro-magnets with non-insulated wires, and of tubular electro-magnets.

PRACTICAL CHEMISTRY.

The second volume to which we desire to call the attention of our readers is a French translation of technological and industrial chemistry, by F. Knapps, Professor at the Brunswick Polytechnic School. This important work, already much esteemed in Germany, has passed through its third edition, and has now been translated by two State engineers of great experience in practical chemistry, and is presented to French readers, enriched by all the documents relating to French chemical industries, similar to those in Germany, which were treated upon in the original work. We have now one volume, the first of nine, which will complete the work. This one is devoted to the study of water and of fuel. It is full of interesting facts;-all the industrial operations relating to these two indispensable auxiliaries to industry are studied out in detail. Amongst others, there are important chapters on the following subjects: the industrial employment of water, with the means of analysing it, and neutralising impurities by suitable applications; the treatment of waste water from manufactories, and of sewage water, the manufacture of aërated and artificial water, the production of ice. In the study of fuels there are passed in review, the combustion of heat, wood, and of liquid and gas fuels. We have, however, space only to notice this new publication, and content ourselves by adding that it will probably form a richer and more complete encyclopædia than has ever before been published.

NOTES FROM THE SOUTH-WEST.

Failure of an Attempted Launch.—A few evenings since an attempt was made at the shipbuilding yard of Messrs. Batchelor Brothers, of Cardiff, to launch a large iron screw steamer built by that firm for Messrs. Marychurch and Co., of Cardiff. The vessel stuck, however, when about half way down the slip, where she has remained for several days.

The Port of Newport.—The total exports of coal from Newport in June to foreign ports were 29,129 tons., whilst the exports coastwise were 72,310 tons. The exports of coke, foreign and coastwise, were 438 tons. The pig, bar, and railway iron exports of the month were 29,793 tons. In this latter total Genoa figured for 1000 tons; New York, for 8851 tons; New Orleans, for 1000 tons; San Francisco, for 4684 tons; Talcahuano, for 1492 tons; Trieste, for 1356 tons; and Ulo (Peru), for 1550 tons.

Iron for the United States.—On Saturday the Alten Besse cleared from Newport for Portland with 230 tons of iron supplied by the Ebbw Vale Company, and 1008 tons of iron supplied by the Rhymney Iron Company.

South Wales and West of England Coal and Metal Markets.—A market was held at Swansea on Saturday. Business in tin plates was firm. Pig iron of good quality maintained its price; very large quantities of hematite pig and ore are being received at the Welsh ports. Considerable difficulty is experienced in obtaining cargoes of Somonostro ore. Forest of Dean ore was in good demand on Saturday; new sinkings are about to be made, among others by the Ebbw Vale Company which has a large property in the district. Mr. Kelly is introducing Oxfordshire iron ore from the King's Sutton mines; it is said to combine purity with cheapness.

Newport Alexandra Docks.—The requisite capital for the completion of this undertaking has been subscribed, and the last contract has been accepted by Messrs. Griffiths and Thomas, who have satisfactorily carried out the works to the present point. Within a few days it is expected that between 600 and 700 men will be engaged upon the works remaining to be executed.

The Steam Coal Trade.—The steam coal trade of South Wales cannot be considered in a satisfactory condition, and while the disastrous strike in the Aberdare and Rhondda Valleys continues, no improvement can be looked for. In the house coal trade there has been rather more doing than usual.

South Wales Atlantic Steamship Company.—Mr. John Laughland, the manager of this company, reports that satisfactory progress is being made with two steamers which are being built for the company on the Clyde. The builders have promised that the first of these steamers shall be completed by the end of the year, and in that case she will be ready to sail in February. The other vessel will be ready for sea a fortnight or three weeks afterwards.

The Aberdare Valley.—Work has been resumed this week at the Nantymelyn colliery. There are some hopes of a termination of the strike in the Aberdare Valley. The first tram of coal brought to the pit's mouth at the Nantymelyn colliery was adorned with evergreens.

State of Trade at Merthyr Tydvil.—Orders for iron from Canada and the United States continue to be received at Merthyr Tydvil. Little is, however, doing on Russian account. Considerable quantities of bars have been delivered for consumption. The quantity of coal on offer being unequal to the demand, prices are rising.

Welsh Shipping Movements.—The Hildegaard has cleared from Cardiff for New York with 660 tons of railway iron supplied by Messrs. Guest and Company. The L. L. Sturges has cleared from Newport for New Orleans with 1000 tons of iron supplied by the Blaenavon Iron Company. The Stephenson screw steamer has cleared from Cardiff for Port Said with 1524 tons of coal. The Maggie Hammond has has cleared from Cardiff for Galveston with 750 tons of railway iron supplied by the Aberdare Iron Company. The Ebenezer has cleared from Cardiff for New York, with 650 tons of railway iron supplied by Messrs. Guest and Company. The Lord Palmerston has cleared from Cardiff for Galveston with 650 tons of railway iron supplied by the Aberdare Iron Company. The Carolina has cleared from Newport for Galveston with 800 tons of railway iron supplied by the Ebbw Vale Company. The Princess Alexandra has cleared from Cardiff for Ancona with 245 tons of bar iron supplied by the Llynvi Iron Company. The Adger has cleared from Cardiff for New York with 600 tons of railway iron supplied by the Dowlais Iron Company.

Taff Vale Railway.—The revenue of the Taff Vale Railway continues to be much reduced by the unfortunate strike among the steam coal colliers. In the week ending July 1 the revenue collected by the company amounted to 4551*l.*, against 6594*l.* in the corresponding week of 1870. The aggregate receipts for the first half of 1871 were 162,687*l.*, as compared with 168,738*l.* earned in the first half of 1870.

Wire Tramways.—Wire tramways are beginning to be adopted at the iron ore mines of the Forest of Dean and Somersetshire for the conveyance of ore to the local railways. These tramways seem destined to exert a rather important influence on local industry.

Trade at Newport.—Hematite and other good pig has been firm with a tendency to higher prices. The manufacturers of tin plates have after mature discussion raised their price to 32s. per box of No. 1 best charcoal. Iron ore of good quality is much required for and prices have been fully maintained. American iron contracts continue to be freely offered, but there is still a comparative absence of Russian engagements. The demand for iron on South American account continues considerable.

The Emperor of Brazil.—It is stated that His Majesty the Emperor of Brazil has expressed a wish to visit the Dowlais and Cyfarthfa Iron Works. The Emperor is expected to be the guest of the Marquis of Bute during his stay in South Wales.

Ebbw Vale Steel, Coal, and Iron Company (Limited).—This company is about to erect a wire railway at Bredon Hills with a view to the removal of spathose ore. With the aid of this ore and spiegeleisen made from it, the directors expect to be able by this time next year to turn out 800 to 900 tons of steel per week. The company is about to issue 5 per cent. debentures to the extent of 100,000*l.*, repayable in three, five, seven, or ten years. The chairman has increased his holding in the company from 600 to 1500 shares. Another director has also increased his investment in the company from 700 to 3700 shares.

The Forest of Dean.—A brisk demand is experienced for Forest of Dean pig. Messrs. Crawshay have recently cut a valuable deposit of iron ore at the Causeway pit. The Forest Vale forge is in full work.

Llynvi and Ogmore Railway.—The district traversed by this line is said to be extremely rich in minerals. At present this mineral wealth has been scarcely touched, but several new collieries are expected to be shortly opened.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—During the latter part of last week the market continued steady with very little change from the prices prevailing this day week; but on Monday there was an advance to 58s. cash and 58s. 3d. one month. Yesterday the market was quiet and rather easier. Business was done at 58s. 1½d. and 58s. one month, 57s. 10d. and 57s. 9d. cash. It closed buyers 58s. one month and 57s. 9d. cash, with sellers 1d. per ton higher. No. 1 G.M.B., 58s.; No. 3, 57s. 3d. To-day the market has been steady, buyers at 57s. 9d. cash and 58s. a month; sellers 1d. per ton more. The shipments of Scotch pig iron for last week were again very good, being: Foreign, 11,085 tons; constwise, 6042 tons; total, 17,127 tons. Same week last year, 9321 tons; increase for week, 7798 tons. Total shipments for 1871, 410,647 tons; 1870, 345,022 tons, showing that the shipments up to this date have exceeded those for the similar period last year by 65,625 tons. It is reported that next week's return will also be good. The imports of Middlesbrough iron into Grangemouth for week ending July 8, 1871, were 2170 tons; same week last year, 1015 tons, increase, 1155 tons. Total imports for 1871, 40,632 tons; 1870, 34,995 tons, total increase for 1871, 5637 tons. The movement mentioned last week with regard to Carron pig iron is not so likely to be carried through as was thought. It is reported that the Carron Iron Company have commenced to erect three new furnaces.

The Finished Iron Trade.—This branch of the trade continues as busy as it can possibly be, considering the limited number of hands which there are at some of the works. The strike at the Glasgow Iron Company's Works, Motherwell, was brought to an amicable settlement last week. The man Hodge accepted work elsewhere, and the men remaining were then in a position to enter into negotiations with Mr. Cassels, the managing partner, on the wages question without raising an issue on any other. They succeeded in getting what they had asked for, namely, 6d. (instead of 2d.) per ton for the labour of taking the puddled balls to the hammer. Work is now going on harmoniously. At some of the establishments it will be suspended for a few days at the end of this week on account of Glasgow Fair holidays.

Royal Scottish Society of Arts.—A meeting of this Society was held in Edinburgh on Monday evening, Mr. John Paterson, vice-president, in the chair. The evening was chiefly devoted to the reading of the reports of committees on various papers read during the session 1870-71. The first report was that of a committee appointed to consider Mr. Robert Louis Stevenson's intermittent light. The committee reported that the problem of lighthouse engineering discussed in Mr. Stevenson's paper is that of producing an intermittent light in which the passage from full light to darkness is instantaneous, and in which no light is lost or absorbed at each interruption. They considered that the proposed arrangement satisfactorily solves the problem for a light with an azimuth of 360°, and that Mr. Stevenson's ingenious contrivance for giving an intermittent coloured and white light approximately the same in intensity is specially noteworthy. In regard to Mr. H. F. Alexander's paper on ventilation, the committee reported that they had not been able to find in it anything novel either in principle or application. The committee appointed to consider Mr. John Reid's supplementary note on his water meter, reported that the favourable views expressed by them in their former report had been fully borne out. In regard to Mr. James Mackenzie's Steel-Yard Indicator, the committee stated that they had carefully considered the merits of the indicator, and were satisfied that it was admirably contrived to answer the purpose for which it was intended. Mr. Thomas B. Johnstone's scheme for a waterproof treasure-safe for ships was reported to be, so far as the committee were aware, an original one. The committee, however, considered that the arrangements proposed for connecting the safe with the vessel were defective, and not such as to secure its separation, should the vessel actually founder. Mr. W. Noble's new danger signal was reported to be ingenious, but the council considered the present system of signalling in use on railways to be fully efficient when properly carried out, and stated that in their opinion Mr. Noble's plan could be no improvement. Mr. Noble's safety couplings were also reported upon, but not favourably.

International Maritime Exhibition at Naples—Prizes to Scotch Exhibitors.—The Italian Consul in this city has been officially informed that of the firms in Glasgow and the neighbourhood who exhibited at the International Maritime Exhibition, Naples, the following have gained prizes as undernoted: Messrs. R. Napier and Sons, first-class gold medal; Messrs. Henderson, Coulbourn, and Co., Renfrew, second-class silver medal and bronze medal; Messrs. M'Culloch, Patterson, and Co., Port-Glasgow, second-class silver medal; The Edinburgh Roperie Company, second-class silver medal; Messrs. Marquis Brothers, Bon-Accord Works, London-road, Glasgow, second-class silver medal; the Shotts Iron Company, second-class silver medal; Messrs. Blackwood and Gordon, Port-Glasgow, bronze medal: Messrs. H. J. H. King and Co., Glasgow, first-class silver medal; Messrs. Thomas Edington and Son, Glasgow, bronze medal; the Monkland Iron Company, second-class silver medal.

Large Contract for Pipes.—The large contract for cast iron pipes required by the Russian Government for Odessa has been secured by a well-known Glasgow firm of gas engineers and pipe founders, namely, Messrs. R. Laidlaw and Sons.

Exports of Wood-Pulping Machinery.—A quantity of machinery, weighing about 30 tons, was exported from Granton in the s.s. Scandinavia for Gothenburg a few days ago. It is to be used in a large mill in that vicinity for the conversion of wood into pulp for paper-making. Gentlemen who have lately returned from Sweden state that the erection of these mills is going on rapidly, and several of them are already at work in the wooded districts. Grinding was formerly the mode of reducing the wood to a glutinous state, but compressed steam with chemical preparations is now being used with success. Skilled workmen are being sent out from this country to erect the machinery and put the mills into working order. A similar consignment of machinery was exported to Gothenburg in the Scandinavia about a fortnight ago.

Dundee Water Commission—Reduction of the Rates.—At their meeting last week the Dundee Water Commission followed the example recently set them by the Gas Commissioners. Finding their revenue in a most favourable condition, they resolved by a majority of twelve to five to reduce the domestic water rate from 1s. 6d. to 1s. 3d. per pound. Notwithstanding this great reduction it will doubtless be a long time before the Dundonians are in such a favourable position as the citizens of this city, where the same rate was recently reduced to 8d. per pound, while the supply of water is 50 gallons per head per day.

The Edinburgh and Districts Water Bill.—This Bill, promoted by the Edinburgh and Districts Water Trust, and intended to use St. Mary's Loch for an additional supply to Edinburgh, Leith, and Portobello, was rejected by the Committee of the House of Lords on Friday last, on the ground that the present supply from the Pentland Hills is not sufficiently taken care of, and the area of supply not completely utilised. The promoters are greatly crestfallen at their defeat, and the opposition are highly elated at their victory. It is said that the promoters' expenses are between 20,000*l.* and 30,000*l.*

Tay Bridge.—Active preparations are now being made for the erection of this bridge. At the south end, offices as well as a temporary pier for the landing of material to be used in the construction of the bridge are being erected. Already about 80 yards of the pier are finished, while the rest is being pushed on as fast as possible.

LAKE SUPERIOR IRON ORE.—The quantity of iron ore raised in the Lake Superior mining district last year was 856,471 tons, as compared with 635,238 tons in 1869, and 507,813 tons in 1868. In 1865, the corresponding total did not exceed 196,256 tons; and in 1860, 116,908 tons. The quantity of pig iron made last year was 49,298 tons, against 39,003 tons in 1869.

RANSOME'S WOOD-WORKING MACHINERY.

WE illustrate this week, on pages 22 and 23, three new wood-working machines exhibited in action by Messrs. Allen Ransome and Co., of Chelsea, at the Royal Agricultural Show, at Wolverhampton. The first of these machines is the "complete joiner" of which we give end and side elevations on page 22. This machine is an improvement on Messrs. Allen Ransome and Co's well known general joiner—itself an excellent machine by the way—illustrated and described by us on pages 36 and 38 of our ninth volume. As in the last mentioned machine, that we now illustrate has the saw spindle distinct from that carrying the planing and moulding cutters, each spindle having its own fast and loose pulleys for stopping and starting. This arrangement enables the two parts of the machine to be worked quite independently of each other, and, in fact, renders it practically two distinct machines.

The arrangement of the saw spindle and its table, &c., in the machine we now illustrate is similar to that adopted in the general joiner we formerly described. The saw table rises and falls, and the saw spindle can be fitted with cutters for grooving, rebating, &c., while the fence plate, which is adjustable to any angle, is hinged so that it can be turned down at the end of the table leaving the latter clear for cross cutting. In the general joiner formerly described the cutters for planing were carried by the overhanging ends of the pair of cutter spindles, and from the nature of the arrangement the width of planks which could be satisfactorily dealt with had to be limited to 7 in. In the present machine, however, the cutter spindles have been lengthened, and while the tenoning cutters are of course carried by the overhanging ends as before, the cutter blocks for planing are mounted upon the main part of the spindles between the bearings. This gives a much more rigid arrangement than that formerly described by us, and enables the width of the planing cutters to be increased so as to plane planks 9 in. wide. Besides this the new machine is provided with a pair of vertical cutter spindles which carry cutters acting on the edges of the planks, and the machine is thus enabled to plane, groove, tongue, edge, thickness and bead at one operation boards up to 9 in. wide. Single or double tenons can also be cut and the shoulder scribed, at one operation. The pieces of wood on which the tenons are to be formed are clamped down to a light sliding table as in the general joiner, and the tenons having been cut by the cutters mounted at the ends of the cutter spindles as shown in the end elevation, the table is shifted so as to enable the lower shoulder of the tenons to be scribed by suitable cutters mounted on one of the vertical spindles already mentioned, the same spindle being also provided when necessary with a drunken saw for dividing the tenon into two. It is an important feature in this machine that the planing portion is permanent and is thus always ready for work. The wood to be planed or moulded is fed up to the cutters by a pair of feed rollers, both of which are driven, the top one of the pair being at the same time free to rise and fall to suit irregularities in the thickness of the plank.

Another addition to the present machine, which distinguishes it from the general joiner formerly described, is the provision which is made for cutting circular mouldings. The cutters employed for doing this work are carried by a third vertical spindle shown towards the right-hand side of the end elevation, this spindle being capable of being raised or lowered so that the cutters at its upper end can be made to project the desired distance through the table at the saw side of the machine. The cutters are protected by a revolving guard, as in Messrs. Ransome's other moulding machines formerly described by us.

The general details of the machine we have described are exceedingly well worked out, and the tool is altogether a very useful one. The cutter spindles, we should mention, are all of "core annealed" cast steel, and the bearings are very long, and are lubricated from below in a very efficient manner.

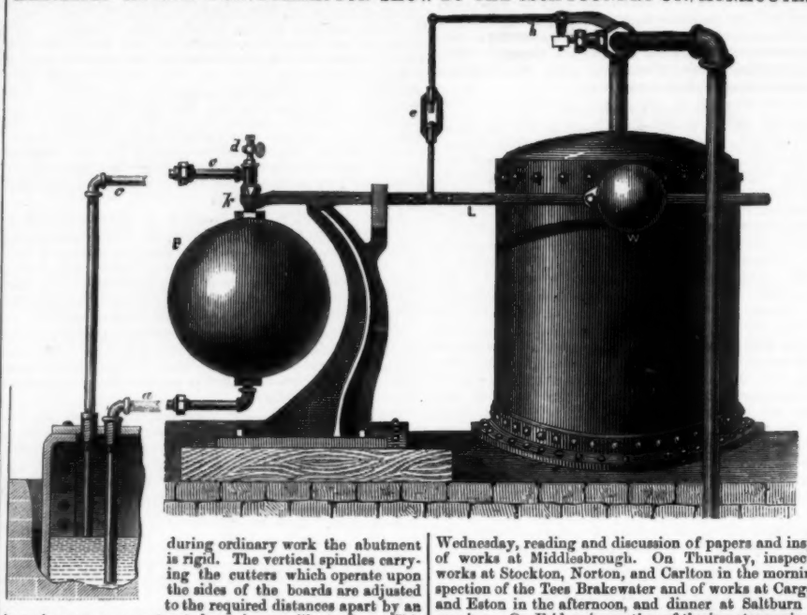
The next machine shown by our illustrations is an 11 in. portable deal frame, of which we show side and end elevations. In this machine the swing frames are arranged on the equilibrium principle, being worked by cranks arranged opposite each other, and thus but a very small and light fly-wheel is required, while at the same time the machine may be driven at a very high speed. The deals are fed to the saws by three feed rolls, all of which are driven while the middle roll is force to rise or fall through a certain distance, being kept up to its work by springs. This arrangement enables the three rolls to at all times exercise their propelling power upon the timber notwithstanding any irregularity of the latter. The arrangement of gearing for driving the feed rolls will be readily understood from the engravings. The rate of feed we should mention, may be varied from 2 ft. to 6 ft. per minute, and with an average number of four cuts the machine will saw 250 12 ft. deals in a day of ten hours. The machine has a substantial framing cast in one piece with the bed plate, while the design generally is very neat and compact.

The third and last machine, shown by our engravings on page 23, is a combined planing and moulding machine capable of taking in boards 12 in. wide by 4 in. thick, and specially designed by Messrs. Allen Ransome and Co., for turning out heavy mouldings, skirtings, flooring boards, &c. The main framing of the machine consists of a single casting, to which all the working parts, including the countershaft, are attached, thus securing great steadiness. The arrangement of the cutters will be readily understood on reference to the views given on page 23; but we may explain that the portion of the table over which the board passes after it leaves the bottom cutters, rises and falls, so that whether a light or heavy cut be taken, the board always has a fair bearing throughout its length. The plate bearing upon the upper side of the board, and forming what may be termed the abutment for the bottom cutters, is held down by springs, but these springs are so stiff that they only yield in the event of an undue amount of strain being thrown upon them, and thus during ordinary work the abutment is rigid. The vertical spindles carrying the cutters which operate upon the sides of the boards are adjusted to the required distances apart by an ingenious arrangement not shown in our illustration. This arrangement consists of two screws, one right and one left-handed, placed one with the other. When the inner screw only is turned one of the spindles only is shifted, but by clamping the two screws together by a set screw provided for the purpose, the two spindles are moved simultaneously from or towards each other as the case may be.

There are two pairs of feed rolls 8 in. in diameter, both pairs being driven so that the necessary feeding power is obtained without resorting to the practice of giving the rolls roughened surfaces. The rate of feed can be varied from 10 ft. to 30 ft. per minute, and by turning a single handle conveniently arranged, the two top feed rolls can be adjusted to take in thick or thin boards, as may be required. Like the complete joiner and other high speed machines made by Messrs. Allen Ransome and Co., the combined planing and moulding machine of which we have just been speaking has self-lubricating bearings and spindles of core annealed cast steel, while the workmanship of this and the other machines we have described is everything that could be desired.

BERRYMAN'S WATER LEVEL REGULATOR.

EXHIBITED AT THE WOLVERHAMPTON SHOW BY THE ISCA FOUNDRY CO., MONMOUTHSHIRE.



NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a capital attendance on 'Change at Middlesbrough. The prices quoted were as follows: No. 1, 51s. 6d.; No. 2, 50s. 6d.; No. 3, 48s.; and No. 4, 47s. The market closed firm at these rates, and it is a fact that a few parcels were actually sold at 48s. 6d., No. 3. This, however, was to prevent the further detention of steamers who had been waiting in the Tees for iron to complete their cargoes. Out of the total number of blast furnaces, viz. 126, there are 119 blowing. There are fourteen new furnaces in course of erection, most of which are in the growing district of Middlesbrough. The make per month as shown by the June returns of the Cleveland Ironmasters' Association is now nearly 156,000 tons. Although the make is so heavy the stocks do not amount to 90,000 tons. Shipments are very brisk and makers have contracts on their books which will keep the blast furnaces in full operation during the whole of the present year.

The Finished Iron Trade.—Throughout the North of England the finished iron trade is in an animated condition. Rail makers are very busy, and continue to receive fresh orders at fair prices. The bar trade is good, and there is a capital demand for plates and angle iron. The extensions of works at Stockton and Middlesbrough are making satisfactory progress.

Termination of the Strike of Blast Furnace Men at Middlesbrough.—We intimated last week that a number of the men at Mr. Thos. Vaughan's blast furnaces at Eston had returned to work on the terms he had offered them a few days previously. Since then the whole of the men have resumed their places, and the furnaces are working as usual. One or two firms who had not revised their wages list for some time have agreed to pay their blast furnace men at the same rate as those in the employ of Mr. Vaughan, and anything like an organised strike for wages has been prevented.

The Institution of Mechanical Engineers.—In accordance with an invitation from Middlesbrough, the Institution of Mechanical Engineers will this month hold their annual meeting in that growing town. The approximate programme of the proceedings is as follows: On Tuesday the 25th inst., reading and discussion of papers in the morning, and inspection of works in Middlesbrough in the afternoon. On Wednesday, reading and discussion of papers and inspection of works at Middlesbrough. On Thursday, inspection of works at Stockton, Norton, and Carlton in the morning; inspection of the Tees Brakewater and of works at Cargo Fleet and Eston in the afternoon, and dinner at Saltburn in the evening. On Friday, inspection of the ironstone mines; and on Saturday, inspection of works at Darlington, Hartlepool, and Whitby Valley Works.

Engineering.—The engineering trade is good. There is a great demand for marine engines, and the locomotive departments are well supplied with orders. Several bridge-builders, however, are still short of work.

Shipbuilding.—All the shipbuilders on the northern rivers continue as busy as possible. As fast as they get vessels launched they receive orders for new steamers.

Co-operative Engine Works at Newcastle.—The proposal to form a co-operative company to purchase the engine works of the late R. Morrison and Co., Ouseburn, Newcastle-on-Tyne, has met with every encouragement. A company with a nominal capital of 100,000*l.* in 20,000 shares at 5*l.* each has been formed, and have taken possession of the works, which will be conducted on an excellent co-operative plan.

The Ironworkers of the North.—The ironworkers of the North of England have applied for an advance of wages. They desire 1*s.* per ton on the present price for puddling and 10 per cent. on mill and other work. The Board of Arbitration and Conciliation leave the question under consideration. The arbiter, Mr. Thomas Hughes, M.P., is to be supplied with information, showing him the exact position of the trade, and he will be able to say whether the men are entitled to an advance, and if so to what extent. Neither masters nor men will be inconvenienced in the meantime, as work will be continued pending his award. The engineers of the North of England should take a lesson from the ironmasters and settle their differences by arbitration.

BERRYMAN'S REGULATOR.

WE illustrate, above, a low water level regulator, which was exhibited by the Isca Foundry Company at the Agricultural Society's Show at Wolverhampton, attached to one of Miller's sectional boilers.

The apparatus consists of a cast-iron sphere, with two pipes leading from it into the boiler, the one from the top, the other from the bottom. The former pipe descends within the boiler, to the line of lowest water level, the other is carried to a greater depth. The sphere is suspended by knife edges, *k*, upon the end of a lever, as shown in the engraving, which is pivoted on a bracket at the side of the boiler. Attached to the lever is a link, *c*, as shown, taking hold of lever, *h*, which actuates the water valve regulating the supply to the boiler. When it is put in operation, the tap, *d*, is turned, to permit the exit of air, and the pressure in the boiler fills the sphere with water. Thus weighted, the lever, *h*, is maintained in one position, and the water supply is shut off from the boiler. But if the water falls beneath the lowest level, the steam enters the pipe, *c*, and replaces the water which passes back into the boiler through the pipe leading from the bottom of the sphere. The diminished weight of the sphere upsets the equilibrium of the levers, L and *h*, the water valve is opened, and the normal level restored. In another modification, a whistle can be sounded by the disturbance of the sphere, and the alarm thus given is continued until the water in the boiler has risen sufficiently to cover the end of the pipe.

THE MONT CENIS TUNNEL.—Alarming reports have been circulated of late as to slips of earth, &c., at this tunnel. The members of the Paris Committee of the Upper State Railway Company have not, however, received any official information upon the subject.

LIGHT RAILWAYS.

A PAPER on the above subject was read before the Civil and Mechanical Engineers' Society, on Friday, 30th June, by Mr. William Lawford, M. Inst. C.E., who stated that the subject of light railways had for some time past occupied the attention of engineers and others, and was one well worthy of being considered in all its aspects, whether looked upon from a commercial or an engineering point of view; for branch lines as feeders to main lines, they would doubtless prove valuable adjuncts to the existing system of the country, especially in those districts where the natural features of the land would otherwise require expensive works. It is a well known fact, that many of the old constructed branch lines in this country are suckers from, rather than feeders to the parent lines; one important feature in connexion with light railways must not be lost sight of, namely, that it would be impossible to carry on them a large and rapid passenger traffic, such as is now the case with the main lines of the country. A large and rapid traffic means heavy engines and heavy rails, &c., but for an omnibus and light goods traffic, a light railway with light permanent way materials, light engines, &c., might be made with great advantage, not only to the travelling community, but also to shareholders.

The author did not enter into the question of gauge, but for the present purpose assumed the 4 ft. 8½ in. or narrow gauge to be the practical gauge of the country, and he wished it to be clearly understood that by the term "light railways" was meant branch lines from existing main or trunk lines, to districts where the traffic was still undeveloped, constructed, however, in a thoroughly substantial and permanent manner, with all the parts made sufficiently strong to carry a maximum load of 5 tons on each pair of wheels.

With regard to the cost of light railways generally, he thought that from 3000*l.* to 3500*l.* per mile according to the nature of the country would be sufficient for a single line of railway (4 ft. 8½ in. gauge) and works, exclusive of the cost of land, and that with light weights, low speeds, (and this must be insisted upon) and flexible rolling stock, the first cost of construction, and that most important item the cost of maintenance as compared with ordinary railways might be materially reduced. He further stated that the question of sharp curves and steep gradients entered largely into the present subject, but he thought it would not be denied, that a line with steep gradients and sharp curves, constructed at a moderate first cost, would give a lower final result in working expenses (taking into account the saving of interest on capital) than a line made at a heavy cost with easy gradients and large curves.

Railway accommodation had become almost as much an essential to this country as air and water. It might have answered the purpose of certain localities that they should enjoy railways, and that others should be deprived of them, but the experience of the past had taught wisdom, and whereas in former years, landowners and others used their utmost exertions to drive railways from them, they were now raising their voices to have them brought to their very doors. Expensive tunnels, high embankments, deep cuttings, magnificent viaducts, palatial stations, &c., were not required, nor should the light railways be laid out with the view of leaving to posterity, monuments of engineering skill and extravagance, but all the latest improvements and inventions should be adopted, by means of which, even a district of hills and valleys, might be supplied with railway accommodation at a comparatively moderate cost, and there was no doubt that in many instances the lines would be executed by the landowners themselves and others locally interested, who would of course be opposed to all unnecessary expenditure.

The author then gave a description of a short line of light railway, which his firm had lately constructed for His Grace the Duke of Buckingham and Chandos, by means of which the Duke's estates at Wootton are brought into connexion with the Aylesbury and Buckingham Railway, at Quainton. This line (4 ft. 8½ in. gauge) is 6 miles in length, with a branch of 1¼ miles, it is throughout eminently a line of light works, and with few exceptions a surface line, the highest embankment being 12 ft., and the deepest cutting 10 ft. There are no road bridges, the turnpike and other roads being crossed on the level.

The rails are bridge rails, weighing 30 lb. per yard, and are secured on to longitudinal creosoted timbers 6 in. × 6 in. by means of fang bolts. There are transoms 4 in. × 4 in. at every 12 ft. kept in their places by a wrought-iron tie-rod ¾ in. diameter. The ballast is 10 ft. wide, and is 6 in. to 9 in. thick under the bottom of the timbers; the line is only partially fenced, the existing hedges being utilised for that purpose.

The main line starts from the Quainton station of the Aylesbury and Buckingham Railway, crosses the Aylesbury and Bicester turnpike road, about 1 mile to the west of Waddesdon, passes through Westcott and Wootton and terminates at a point near the road leading from Wootton to Brill. The sharpest curve is ten chains radius (excepting that at the junction of the branch line, which is eight chains radius) and the steepest gradient 1 in 60.

Nearly 4 miles of the line have been in use since the early part of this year, and in the month of March alone more than 3200 tons were carried over it; the line is at present being worked by horses. The estimate for the works was 1400*l.* per mile, exclusive of the cost of land, and the author did not think that amount would be exceeded. It must be remembered that there were no parliamentary expenses incurred on this line, that the works throughout are light, that all the roads are crossed with level crossings, and that (with the exception of laying the permanent way, points, and crossings), the works have been executed without the intervention of a contractor.

INDIAN APPOINTMENT.—Mr. W. Blaikie, civil engineer to his Highness the Nawab of Joonaghur, has been appointed to act as local engineer in Kattywar, in the room of Mr. R. Booth, C.E., who has obtained six months' leave of absence.

THE NEW DOCKS AT NEW YORK.

THE New York Dock Commissioners have issued the following statement of their plans:

"In arranging a new system for the accommodation of the shipping business of New York, the chief object has been to render it as simple and economical as practicable. The English system of tidal docks has been rejected as too expensive, and as inapplicable here; the variations of the tide being so small as to render such a system unnecessary, while our ample and secure anchorage grounds and extensive water front render it entirely practicable to furnish accommodation for any future commerce by a much more simple system.

"The main features of the new system are—a wide river street, bounded by a permanent wall of masonry, and much more ample piers than the present. On the North River side the river street will be 250 ft. in width, on the East River 200 ft. as far as Montgomery-street, thence 150 ft. wide to Grand-street, thence 200 ft. to Thirty-first-street, thence 175 ft. wide. This width will afford ample space for any future railway system, as well as sufficient room to permit easy access to the piers, and uninterrupted transit along the river front. None of the new piers will be less than 60 ft. wide, except in particular cases, where only one side of the pier can be used (as in those adjacent to ferry slips), others 80 ft., and others 100 ft. wide. It is proposed to arrange to cover all piers that require it with a suitable one-storey shed, affording the requisite facilities for handling freight. It is proposed to leave the erection of storehouses of several storeys entirely to private enterprise, under the direction of the Board. The slips will be made of a width adequate to the purpose for which they are to be used. At the river wall there will be a depth of water of 20 ft., except where the absence of piers will permit large vessels to lie alongside, where the depth will be 25 ft. or more.

"Into the construction of a limited number of the piers, stone and iron will enter, but the great majority will be of wood, built in the best manner. Considerations of the necessary economy lead to this conclusion, for the large wooden piers can be so made as to afford all the necessary facilities at a comparatively small outlay. The piers will all be on supports of such a nature as to allow free passage to the water.

"Under the present system there are, from Sixty-first street, N. R., to Fifty-first street, E. R., a wharf line of 150,293 ft., or 28½ miles, with a total pier area of 2,323,668 square feet. By wharf line is meant all that portion of the river wall and piers that vessels can approach. Considerable portions of this wharf line are practically useless from insufficient depth of water and other causes. Under the new system there will be a wharf line of 37 miles, and a pier area of about 5,105,000 square feet, from Sixty-first-street, N. R., to Fifty-first-street, E. R.

"It is proposed first, to complete the system from Grand-street to West Eleventh-street, within which limits there will be a wharf line of about 21½ miles, sufficient to accommodate the commerce of the city for some time to come, when the advantages of the new system are taken into consideration."
—*Chicago Railway Gazette.*

RAILWAYS IN PERU.—The works of a line intended to connect Puno with Cuzco, the old Inca capital, have been inaugurated. Mr. Henry Meiggs is the contractor. Locomotives have been running of late for a distance of 46 miles on the Pisco and Ica line. A station has still to be built at Ica.

NEW ORLEANS.—It is asserted that statements which have appeared in reference to the injuries occasioned by ruptures of the Mississippi levees have been much exaggerated. The city surveyor of New Orleans reports that the drained area comprising New Orleans is 15,577 acres in extent, and that the overflowed district only comprises 1647 acres.

SOUTHERN OF FRANCE RAILWAY.—The shareholders in this system, which escaped without injury during the late war, will receive a dividend for 1870, at the rate of 7 per cent. per annum. The profit realised upon the old network last year declined, however, to 878,795*l.*, as compared with 910,260*l.* in 1869*l.* The ratio of the working expenses last year was 36.79 per cent.

STEEL RAILS FOR THE GRAND TRUNK.—Two vessels have been unloading steel rails at Montreal from Barrow, England, for the Grand Trunk Railway of Canada. They are the first instalment of about 9000 tons contracted for by the company to be delivered at Montreal during the present season. These rails are to be laid down between Coaticook and Toronto. The whole of the company's main line is to be steel railed by degrees.

STATUE OF PROFESSOR MORSE.—A statue of Professor Morse in the Central Park at New York has been formally unveiled. The statue is placed on the Fifth-avenue drive and is of bronze, heroic size. The dress is modern, surmounted by a cloak with a fur collar falling from the left side and held up by the left hand in which is a telegraphic despatch representing the first sent by a submarine cable. The other hand rests upon a small telegraphic instrument which stands upon a column.

THE GAUGE QUESTION IN THE UNITED STATES.—Some of the American papers have been discussing the desirability of constructing narrow gauge lines. One of them, an influential New York journal, suggests that the two new Pacific lines should be carried out on a 3 ft. gauge. The journal asks: "Why should not these two companies save from 50,000,000 to 80,000,000 dollars by adopting a gauge which has been deliberately accepted as that on which 10,000 miles of railroad are to be built in India?" We need not add that 3 ft. is not the Indian gauge.

PEAT FUEL.

TO THE EDITOR OF ENGINEERING.

SIR,—In common with many others on this side of the water, I have read with much interest, the several articles relating to peat and its utilisation for fuel, which have recently appeared in your columns, and as a comparison of the experience and observation of different parties under different circumstances, can hardly fail to be of advantage to those who would prosecute the enterprise for practical results, I venture to give a little concerning my own during the six years now last past, in which I have given close personal attention to the matter in all its stages, from the bog to the consumption and use of the fuel.

Differing, as I do, from some of the views expressed by your correspondents, I write in no spirit of criticism, but rather in view of the importance of the subject, as relating to the fuel question, than which none is of wider range or involving greater interests for manufacturing, transportation, and household purposes.

The deposits of peat suitable for fuel, both in Europe and America, are simply immense, and it cannot be that they have been allowed to accumulate to this vast extent without a wise purpose in the ordering of Providence. They are easily accessible, principally located in those regions where the climate is such as to require fuel for the comfort of mankind, irrespective of demands for its use in the arts, &c., and in some cases, as in the vast prairie regions of the West, where neither wood nor coal are found, the deposits appear, at present, to afford the only local supply of fuel.

That it is a fuel, and valuable as such, is a fact, established and acknowledged, but, like most of the bountiful supplies in the storehouse of nature, some preparation is required to fit it for the service of man, and to adapt it for handling and transportation, which are alike essential for any article of traffic and use.

How to accomplish this in the best manner, and at the least expense, is the question involved in the recent discussion in your columns, and which for years has been repeatedly raised. It is by no means a novel one, for questions of similar character are sure to arise whenever we attempt to utilise any of the crude materials in which the world makes traffic.

For hundreds of years peat has been used as an article of fuel (we read of it certainly as early as the twelfth century), in some regions in very large quantities, the methods of preparation in the majority of cases being of the most primitive order; but we of the present day are wont to seek for improvements, and accordingly the last fifty years has witnessed much of effort and experiment to that end, the narrative of which would be curious, and, in one respect at least, instructive, i.e., the lesson would be plainly taught that it is always well, before entering upon a new field of enterprise, to learn what our predecessors have done, if for no other reason than to avoid their follies and escape their mishaps.

Much more has been done during these fifty years than the majority of people are really aware of, though the effort has been mainly expended on one or the other of about three well-beaten tracks, within the lines of which nearly all the various methods may be resolved. Numerous machines have been devised and patented, a few only of which have actually been built and operated; some with good measure of success, others with loss. Some have been constructed on principles entirely at variance with the character of the material to be treated, or the results to be obtained, while many have made a fair commencement, gone about so far, and stopped just short of the one or two steps more which would have shown a good degree of success. Notwithstanding repeated failures, there has ever been partial success, the actual results of all well-conducted experiments tending to show that the thing is entirely practicable, and that when accomplished the numerous deposits of peat hitherto considered of trifling value, will have an actual and acknowledged importance fully equal to forests and coalfields.

The enterprise, therefore, appears to be of a legitimate business character, with large interests at stake. What wonder, then, that some should have persistently pursued it, and that fuel consumers should look with favour upon, and urge its prosecution, as in this country they are certainly doing now, and that with increasing goodwill as they become intelligently informed upon the subject, and convinced, as many are by their own observations on the merits of the fuel which it is now found practicable to produce.

It is rarely the case, however, that I have seen anything like a distinct reason given for any of the processes of treatment or devices for manufacturing the fuel, but a kind of mystery has seemed, by common consent, to be allowed to envelope the whole matter; whereas to my own mind, the true process appears to be very simple, and the reasons for it plain. Moreover, they are within the comprehension of all, and if generally understood can hardly fail to lead to the rapid and widely extended prosecution of the enterprise as a legitimate business, and in such manner as to have an important bearing upon the great question of cheap fuel for the people.

Now, theories will not avail to give the desired results. It is a matter requiring practical attention, and cannot be handled with gloves.

Peat is pure decomposed vegetable matter, generally occurring in moist localities where the growth consists mainly of mosses, rushes, flags, coarse grasses, &c., in many cases of very rank growth, not unfrequently giving place, however, after ages of accumulation, to trees, which in time may also fall, become decomposed, mingle with the mass, and give place to other and successive growths. The deposit so accumulated is evidently as pure vegetable matter as the wood in the trunk of a tree, impaired only by the fine dust which may have floated in the air, and settled down upon and mingled with it, or the particles of earthy matter which may have been washed or blown into it from adjoining lands.

The process of decomposition is simply the earlier stages of carbonising or charring, which is progressing slowly, but just as surely as though it were placed in the fire, so that in

fact, we have as a result, a deposit of pure woody matter in an improved condition for fuel, inasmuch as charcoal is superior to wood.

A black, brown, or grey mass, mud-like and unattractive in its appearance, the visitor to a bog is wont to approach it cautiously with foot and hand, perhaps poke it with a stick, eye it askance, and, inwardly at least, pronounce it an unclean thing. But stop a moment, cut a spadeful, take it in your hands and break it open. There are the perfect forms of leaves, rushes, twigs, &c., precisely as they were laid there years, perhaps ages, ago. Press them and they vanish, almost at the touch, into a soft, cheese-like, unctuous mass, in common with the mosses which apparently constitute the greater and most thoroughly decomposed portion of the material. Close your hand, and open it; it was stained perhaps a little, not with dirt or earthy substance, but with the slight tinge of vegetable colouring matter. It is clearly, then, a mass of pure vegetable material as we have said.

Observe carefully its structure and composition. The mass is tubular and cellular in its construction, and it is composed of solid matter, water and air, the proportions of the two latter being by far the greater, both by weight and measurement, and contained within the tubes and cells referred to.

If a quantity be placed in a close box and pressure applied it cannot affect the solid matter nor the water, for neither of these are capable of compression, but it must take effect solely on the air contained within those cells, which is elastic. From some peats, under some circumstances, it is practicable to express a portion of the water, but as a general thing evaporation has been mainly relied upon to relieve it of moisture. Let it dry then, and as a result increased density is acquired, with some considerable strength and cohesion, though the air cells still remaining generally render it friable, oftentimes to such a degree as to crumble and produce quantities of dust, &c.

Now, if by any means it were practicable to expel the air, which will in many cases be found to amount to from ten to thirty per cent. or more of the volume, and draw out, lengthen, lay side by side, laminate and intermingle the particles of peat or solid matter, and then, by evaporation, rid the mass of the moisture until now retained within it, we shall find that as evaporation progresses, the particles contract with and about each other, until when quite dry we have remaining only the peat in compact form, and as there are neither air nor water cells the mass is absolutely solid, while strength and cohesion result from the process described. At the proper stage of treatment it may be given form by any convenient process of moulding, regard being had in this as in all other matters, to the peculiarities of the material and such method as shall accomplish the desired result in the best manner and at the least cost.

It was after arriving at these conclusions and upon these simple principles that I commenced operations in peat in 1864, and have followed them up very closely to the present time, mainly with a view to the development of a process and the perfecting of machinery adapted for producing from peat a good fuel, in large quantities, in good merchantable shape, and at moderate cost. In this I have been abundantly successful, as is evidenced by the character of the fuel produced and the commendations bestowed upon the process and machinery by those who have adopted them.

Of the various stages of treatment, including the details of handling, drying, and housing, which are of no light importance, now combined in this process, all of which are simple, some have been in operation for several years at my own works, and those of others to whom I have supplied machinery, while others are of comparatively recent introduction, each season's experience having served to overcome previous difficulties and perfect the detail of mechanical appliances, all very simple, easily comprehended, and as easily managed, though from the outset I have seen no occasion to deviate from the general principles on which the process is based.

The process of manufacture is reduced to a well demonstrated system, and the business can be entered upon as prudently and understandingly and on as fair an estimate of expenditure and returns as any other, and with the proper means and appliances and the same prudent and intelligent management which any other business demands, this surely invites attention and gives promise of reward far in excess of most kinds of manufacturing. The preliminary outlay required is small, the returns are quick and the margin for profit to producers is large, even at rates which clearly characterise it as a cheap fuel. With labour at 1.75 dols. per day the cost to produce is less than 2 dols. per ton, while it readily commands 5 dols. per ton at the works, with cost of transportation added. Although competition and large contracts may in time materially reduce the price, as they undoubtedly will, the real value of the fuel and the manifest favour which it meets from all consumers, must ever insure for it a handsome profit to producers.

My own experience leads me to feel that there is no good reason why the immense deposits of peat should not now with less of outlay and more of profit be worked as extensively as coal-fields.

Of the various processes and appliances of English, French, and German origin, alluded to by your correspondents, together with a number of others from the same countries, I have had opportunities for extended and reliable information. Several have and still do produce good fuel, which will probably be quite satisfactory until in the same regions it is made apparent that from the same crude material a better article can be produced at the same or less cost. In other cases large works have been projected on plans, impracticable for successful results, and large sums of money expended, resulting in pecuniary loss, and as a natural consequence giving rise to more or less of prejudice against the enterprise in any form.

In this country peat has been used as an article of fuel in some sections, almost from their earliest settlement; generally in its crude condition as cut from the bog and dried, or at best but very rudely and imperfectly manufactured. During the last ten years, however, numerous attempts have been made to produce the fuel in an improved condition, and as a merchantable article, and notwithstanding there have been many absolute failures, there has been also a good degree of success. A great deal of good fuel has been produced and has met with marked favour wherever it has been introduced, in many cases from parties largely engaged in manufacturing and transportation, and representing the heaviest fuel consuming interests in the country. The demand for it is widely, earnestly, and in some localities importunately expressed. As yet, the quantity produced is limited, but some works are being enlarged, new ones are in process of construction, and many others are proposed or already projected.

It is a noticeable fact that wherever peat fuel has been manufactured with any good degree of success as regards quality, it has been by methods which have to a greater or less extent developed the principles which I have endeavoured to explain.

The "dry" methods, so called, as the Lithuanian, Exter's, Elsberg's, and others, are now, I believe, entirely discarded both in this country and in Europe. They produced in some cases a material very hard and generally attractive in appearance, but which for many of the purposes for which fuel is required, proved to be practically useless, from the fact of its rapid disintegration while burning. It was, moreover, produced only at a cost which was unremunerative.

All of those methods which involve pugging, rolling, kneading, cutting and stirring, tend in the first place to break up the cells and tubes referred to, and of course discharge the air in some measure, but no mere pugging will effectually accomplish this, nor properly fit it for the subsequent stages of treatment.

The "washing" process, which has seemed to be a principal topic in the discussion in your columns, is practically, and in its results, similar to that which I have described, for, the original structure being broken up and the air discharged while undergoing the process of stirring in a semi-liquid condition, the particles are laid out or laminated by the flow or motion of the water, leaving it in that condition best fitted for a close contraction of the particles as evaporation takes place, or as the mass parts with its moisture, with which, however, it is so largely charged, probably not less than 90 to 95 per cent., that it cannot be moulded or retained in form for handling, and can be managed only in the mass, until sufficient time has elapsed for drainage and evaporation, necessitating extra labour, a very large area for drying, and much time, all of which are important items; while, by the method I have referred to, similar results are obtained in much less time, with less labour, and at less expense, admitting, too, of the treatment of very much larger quantities, a consideration on which the profit or loss of an establishment must oftentimes depend. I have never witnessed the operation, and though much has been said concerning it I have yet to learn that any considerable quantity of fuel has ever been actually produced by a real "washing" process.

Many peats contain undecomposed roots and sticks, which if mingled with the substance when treated in the manner I have indicated, will, of course, retain their own peculiar characteristics, but will be closely compacted within the mass as the process of contraction goes on about them. The larger of these will, however, in most cases, have been thrown out by hand, and in any event the actual percentage by weight will be very small indeed from any bog which is in condition to be worked for fuel of good quality.

It has been my custom not to undertake to remove these, but to cut them up very finely (the mills containing appliances for this purpose), and allow them to form a part of the manufactured blocks, in which they become very closely compacted, the dry result showing perhaps one, two, but rarely so much as five per cent. of wood mingled and manufactured with the peat—a matter of very little importance for ordinary purposes.

A deposit containing any considerable quantity of undecomposed vegetable matter may be worked for just what it is, and the product will bear its relative value in the market, according to quality. It is quite useless to attempt to bring all peats up to the same standard, for they differ in characteristics and value as much as do woods and coals.

The "fibre" of peats, which should not be confounded with the undecomposed sticks and roots, is mainly the straw-like residuum of the growth of vegetation from which the peat is formed, and even in what may be termed very fibrous peat constitutes hardly an appreciable portion of it; indeed, I very much doubt if it would ordinarily constitute one per cent. of the weight of it in its dry condition, though it is possible that in some cases it will reach as high as two or three per cent.

It is hardly appreciable either in substance or strength, yet much discussion has been had concerning it, and doubtless in the estimation of some, not practically familiar with the subject, who have been invited to contribute to speculations where this matter was made to appear of great importance, it has had a theoretical weight and strength which in actual practice we fail to discover.

It is barely possible that in the aggregate these fine soft fibres may afford a very little additional strength to the manufactured fuel, after the manner of hair in mortar, but it must, at best, be trifling.

The machinery invented by Mr. Buckland, exhibited by Mr. Brunton, and referred to by one of your correspondents, was claimed to be especially adapted for removing this fibre, but while it did separate and exclude, to some extent, the undecomposed sticks and roots, it did not separate the fibres of the mosses, grasses, and rushes, of which the peat is principally composed, but it did crush, comminute, and mingle them with the true peat in such manner as to render them almost imperceptible, and hence, probably some, perhaps the inventor himself, were deluded by the idea that success in this respect was obtained—though of little or no real consequence if it had been. The machine prepares the material in excellent condition, as far as it goes, though I do not learn that any provision whatever is made for giving it form, or for handling or removing it, and it is therefore quite incomplete. It requires a large amount of power to operate it, while the quantity of material treated is very small, and in saying that it is for these several reasons practically a failure; I only repeat the opinion already expressed in your columns, and I believe generally acknowledged.

The views I have expressed concerning the Buckland machines, are the result of personal observations on one of them (probably the only one ever brought to this country), which for several weeks was had for trial and experiment at Lexington, where my own operations have been conducted for several seasons past.

I had designed to allude to several other matters mentioned by your correspondents, but fear I have already trespassed quite too much upon your space, and must therefore refrain.

Since writing the above, I have your issue of the 19th May, containing another communication upon this subject, and while it is with the utmost unwillingness that I touch upon anything which may be considered of a personal character, it is but the part of fairness to say that, while the prime object of that letter appears to be to justify the writer of it in a former misquotation and a far-fetched inference, his subsequent quotations give evidence of persistency in the same failing; for one is plainly garbled, another is credited to the wrong author, and a third, given without name, is also inaccurate.

These matters are so plainly visible that any attempt at explanation would only "make a bad matter worse."

His allusion to my own process and machinery is entirely incorrect, and could not have been written by any person at all familiar with them.

The principles involved in the process are the same to which I have made allusion, while the mechanical appliances, simple but effectual, are carried to a degree of perfection exceeding anything of which I am informed for similar purposes, and which have won the highest commendations from numerous parties of engineering and mechanical ability, whom few would be so rash as to dispute, much less to deny, without similar opportunities for examination. The manufactured product of the mills speaks for itself, and I am perfectly content that their reputation rest on their merits alone, without fear or favour.

I have no word of disparagement for any who will make peat fuel by any method. The field is large, there is room for all, and we can better afford to help than to hinder each other; indeed, a generous rivalry would seem most likely to promote the rapid and successful development of the whole enterprise. The simplicity of some and the extravagances of others may all tend in one way or another to shed light upon an enterprise which is yet in its infancy, and for which it were folly in any one to claim perfection at the present stage of development and experience.

The Canadian machinery, invented by Mr. Hodges, of Montreal, and to which the same correspondent makes reference as "washing" machinery, I have had good opportunity to examine, and have seen many thousands of tons of the fuel manufactured by it (will enclose a small sample of it). It does not wash out the fibre, neither does the inventor claim anything of the kind, but he does state that it "removes all sticks and roots, and, eventually destroying the fibre, reduces the peat to a homogeneous mass of soft pulp," &c.

These facts your correspondent had before him in the same volume from which all his quotations above referred to were taken, which was none other than my own work, entitled "Facts about Peat."

The peat-fuel enterprise can well afford to rest its claims to public favour solely upon its merits, and those on whom, in the ordinary course of business, it may devolve to lay these before the people may be perfectly content with the simple and unexaggerated statement of facts.

As to the characteristics of peat, and the best methods of treatment, it is hardly safe for any one to make positive statements concerning them who has not himself worked in the bog, at the mill, and with the fuel, for, mud-like and unattractive as the black mass appears, it holds, nevertheless, many a little secret which confounds the speculations of theorists, and is ever ready to open up curiosities which can hardly fail to interest and instruct an inquiring mind, and shadow forth convincing proof of its just claim to an important place among the undeveloped but abundant resources which a bountiful Providence has laid in store to meet the ever-increasing wants of man.

I mail to you a little work entitled, "Peat Fuel; How to make it, and how to use it," which may be of interest in connexion, and I enclose with this a small sample of peat manufactured by the "Canada" machinery, which, although good, shows the fibre not only not "washed" out, but almost undisturbed; also small samples of fuel manufactured in Massachusetts, Connecticut, Illinois, and Wisconsin, in mills of my own construction, the three former from very fibrous peats, the fibre being still retained, yet hardly discernible; while the latter contains considerable wood. Some small air cells are still traceable in all of them, but all are dense and hard, and, as you will observe, present a fracture almost like stone.

Craving your indulgence for the length of this letter, solely in view of the importance of the subject in its relations to a great variety of interests, and to none more than to those to which your columns are mainly devoted,

I am, yours very respectfully,

T. H. LEAVITT.

Boston, Mass., U.S.A., June, 1871.

NORTHERN OF FRANCE RAILWAY.—Although the Northern of France Railway was, of course, very greatly affected by the war, it has contrived to provide its shareholders with a dividend for 1870 at the rate of 10¼ per cent. per annum. For 1869, however, the dividend was at the rate of 16¼ per cent. per annum. The net profits derived from working last year upon the company's old network lines were 1,490,241*l.*, showing a decline of 521,489*l.*, as compared with 1869.

THE MONT CENIS TUNNEL.*

GENERAL DESCRIPTION OF THE WORKSHOPS AND WATER SUPPLY.†

THE ground lying between the torrent of Rochemolles and the village of that name, being on a slight and regular incline, was chosen as the site for the principal workshops, including the repair shops, the buildings for the air compressors, the dwelling-houses for the engineer, clerks, workmen, &c. In order to secure good communication between these large workshops and the head of the tunnel, a road was built along the side of the Rochemolles torrent 6400 ft. in length. In front of the head of the tunnel, on the top of an embankment, mostly composed of rock excavated from the workings, smaller shops were established for those purposes which more closely appertained to the actual work of excavation, such as sheds for mortar mills, carpenters' shops, and repair shops, for making small alterations, and for doing general jobs to the boring machines, smiths' forges, &c.

At the commencement of the excavation, brick yards were also established, but they were afterwards abandoned, the bricks being provided by contract, and transported from Oulx, where they were manufactured.

On the road leading to these secondary shops, and at some distance from any habitation, was located the chief powder magazine, which contained usually more than 25,000 lb. of powder, and from which, for the sake of safety, the necessary supplies for two or three days were periodically removed, and placed under a shed not very far from the opening of the tunnel, near the shops where the mining cartridges were fabricated. The number of workmen employed in these establishments varied a good deal, the numbers being greater or less, according to the speed with which the excavation proceeded. But the average number engaged in the shops and in the tunnel was 1500, besides 300 more employed in getting stone from the adjacent quarries, and some 200 bricklayers employed by private contractors, so that in all the number of men employed in and about the works at the Italian end was about 2000, not inclusive of those engaged upon transport.

The workmen within the tunnel worked in eight-hour shifts, and thus three times in every 24 hours, that is to say at midnight, at 8 a.m., and at 4 p.m., they were changed; those on the contrary working at the headings had no fixed hours, only changing when each set of men had finished their task of longer or shorter duration, according to the difficulties encountered; the workmen in the shop made on the average 10 hours' work daily.

The water used for driving the different machines was brought from the torrent of Meleget, near the village of Les Armand, along a fine aqueduct in cut stone, and thence through a system of sluices, it passed into the channel, conveying it to the shop. This channel is built in brickwork, and averages 3 ft. 11 in. in breadth, having a capacity of a cube metre per metre of length; it is covered in some places with a brick arch, in others with stone flags; for some distance it skirts the torrent, then turns, and follows the side of the mountains, underneath various torrents, until it crosses the Merdoune, by means of an aqueduct, after a course of nearly two miles. The waters of the Meleget, after heavy rain and thaws, are sometimes very muddy, and full of sticks and leaves, small roots, straw, and other débris, that would interfere with the action of the compressors first employed; in order to prevent any serious inconvenience a large settling reservoir was made near Bardonnèche, and about two-thirds of the distance from the commencement of the conduit. The water rushing into this reservoir with a great rapidity, attained by the fall of the channel, spread itself, losing its velocity instantly, depositing at the bottom the substance of the greatest specific gravity, whilst the lighter ones, floating onwards, were stopped at the outfall of the reservoirs by movable gratings.

THE VARIOUS BUILDINGS AND THEIR USES.

On entering the principal yard of the Bardonnèche road, one sees on the right hand a plain building containing the offices. Near this is the mouth of the tunnel, which is made to connect the great tunnel with the Bussoleno-Bardonnèche line. The length of this connecting tunnel is 820 ft. Opposite the offices stand the dwelling-houses of the employés, and contain a club. Behind it are the wooden store shed, washing house, and infirmary, and not far off are small gas works, and a gasholder standing within a close circular shed. These works, which now only supply gas for lighting up different parts of the yard, were at first intended to make the gas with which it was proposed to light the interior of the tunnel as the work proceeded; but this was found to be attended with great inconvenience, for when blasts were made, the expansion of the air extinguished the gas, and the workmen very often found themselves in perfect darkness, which besides causing confusion and loss of time, permitted the free escape of gas which further vitiated the air, impure already from the explosion of the powder, and the exhalations of the workmen.

Along the banks of the torrent of Rochemolles are the dwelling-houses of the workmen, which are protected against floods by an embankment formed with the rock excavated from the tunnel. The unmarried men had one room awarded to four, the married men lived in separate houses, and each having a room. In the centre of the yard, is a spacious court, round which are ranged, the repair shops, the compressor buildings, and a school house for the workmen's children, and containing the apartments of the masters and mistresses, and a provision store. Opposite this building are two large reservoirs for compressed air, the use of which will be explained hereafter.

The shops for repairing the boring tools, and other machinery, contain every necessary for the purpose, such as lathes, planing machines, drilling machines, shaping machines, &c., besides the smiths' forges and air-driven hammers. The whole of the machinery with this last exception is driven by a 12-horse power wheel. A shop thoroughly well suited for these repairs was absolutely necessary in order that the constantly recurring alterations and repairs required by the perforators, should be done without any delay. The rapid destruction of their tools was due principally to the injurious action of the quartz dust, cut away by them, but also by the violent shocks which they constantly received when at work.

Near the repair shops, and occupying one side of the court-yard, are the compressor houses. The one first completed, containing the water column compressor, is a large covered building, with large windows, and enclosing ten of these important machines, which, however, were, after a short trial, abandoned. Nevertheless, they are worthy of description, for they first led to the idea of mechanical perforation, which has been attended with so abundant a success. As regards these compressors, we must note that the different heights, hereafter mentioned, refer to a horizontal plane, which we will call the effluent level, because it contains that height at which the water stands in the compression chamber when it is full of the air, that is to receive the descending stroke of the compressing column.

If we suppose the spectator standing on this plane, opposite to the compressor buildings on the right and left, he will see before him ten compressors, all of equal dimensions, and divided into two groups of five each; between the two groups are two motors, actuated by the compressed air, each of which works a horizontal rod, opening and closing at regular intervals the supply and exhaust valves of the compressors. We may call this the principal valve motion. Each group of compressors is independent of the other, and has its motor and principal valve motion, but by a very simple arrangement both groups may be worked together, while, if when they are at work it happens that some of them may become impaired, they may be isolated without interfering with the rest.

For the special class of work to which they were adapted these precautions were absolutely necessary, so that under any circumstances a sufficient quantity of air may be secured in order to prevent any stoppage in the boring operations. In front of each of the compressors there is placed an iron receiver with spherical ends, into which the compressed air is delivered at every stroke of the same column of water that effects the compression. These receivers are made abundantly strong. They are all placed in communication with each other by means of a pipe, so that they all operate together, if desired, but may be divided into groups of any number, as may be expedient. By this arrangement the amount of power can be regulated, and repairs effected without causing any delay. The contents of each of the receivers is 600 cubic feet, and in order to ascertain exactly the quantity of air produced or consumed, each receiver was tested by fixed quantities of water being poured in, and the heights of the corresponding levels were marked on a scale outside; in this way the graduations to 3.5 cubic feet were fixed. At 85 ft. 3 in. above the efflux level is the great reservoir, in which the compressing columns unite. These 85 ft. 3 in. mark the height or stroke of the column of compression so soon as it begins to come into action. Inside the reservoir the columns are made with a funnel-shaped top, so as to avoid the effects of the contraction of the water in its flow, and each is provided with a cover, so that the water can be excluded, and the corresponding compressor emptied, and submitted to repairs when desired. The water is led into the reservoir by large iron mains, which lead it from the conduit 65 ft. 7 in. above. These mains are, of course, fitted with all the necessary valves, sluices, &c., for keeping the water under control. At a point still more elevated 164 ft. above the plane of efflux, on the hill side, is the regulating reservoir, having a capacity equal to upwards of 14,000 cubic feet, built in brickwork, and roofed over, the covering being supported on pillars, and earth being placed above for a depth of 3 ft. 3 in. to protect the water from the action of frost. From this reservoir two iron pipes are taken, each communicating with one of the two groups of receivers before mentioned, both groups being connected to the pipe that draws water from the regulating reservoir, and the columns of water contained in these pipes for their height of 164 ft. maintain almost invariably the pressure of air on the receivers. As regards the regulating column the receivers are put in action by means of appropriate valves, together or separately, so that in this detail also they work together or separately, as may be desired.

It was soon found, however, that these compressors became damaged by the violent shocks the valve had to resist, when they were suddenly closed, and hence their use has been abandoned, the simple machines known as the "water-spout" compressors, were found to be more reliable, so that all the compressed air has been produced by these machines. The water-spout compressors at work in the yard, are actuated by seven water wheels; the quantity of water used is small, only 35.317 cubic feet per second, but it has a considerable fall of 144 ft. The wheels were placed one below the other, so that the waste canal of one forms the supply canal of the other, and thus all the fall was utilised by giving 19 ft. 8 in. of fall to each wheel. The wheels are placed in separate buildings; the three lower ones are arranged back to back. A description of one will suffice for all. An iron wheel, 19 ft. 8 in. in diameter and 16 ft. 4 in. wide, gives motion from the shaft on which it is mounted to two heavy connecting rods, actuating two pistons. On each side of the wheel, stand coupled together two large cast-iron cylinders, vertical, but turned round at right angles at the floor level so as to form horizontal cylinders in which the pistons before mentioned work slowly, their alternate motion being communicated to a water column which rising and falling alternately in the vertical part of the cylinders, compresses the air which is admitted, into, and forced from the cylinder by means of a set of ordinary inlet and outlet valves.

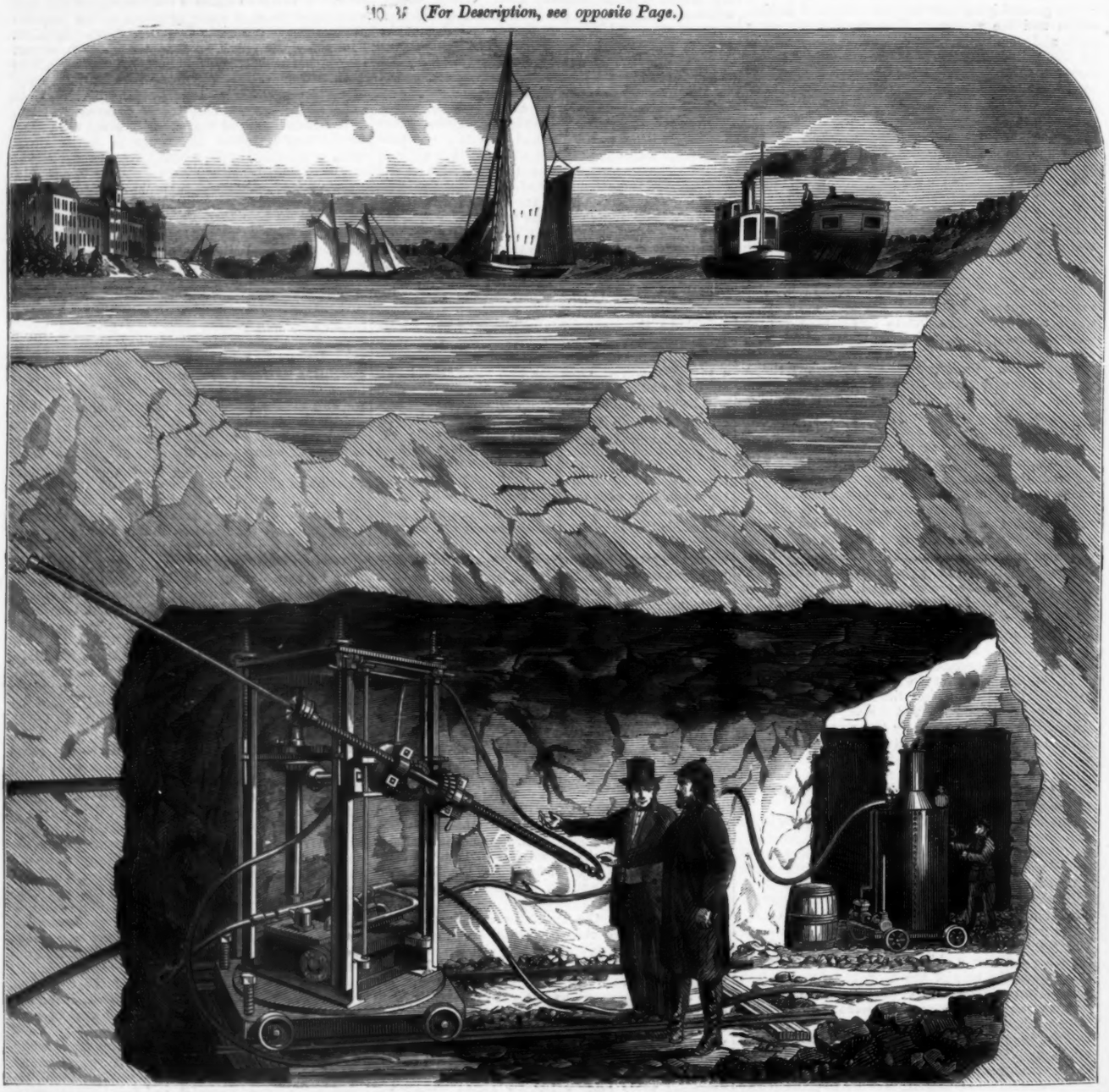
An iron staircase leads to a gallery from which the upper part of the machinery may be examined. Everything works with the utmost precision, the motion is perfectly regular and free from shock, so that these machines work constantly for years without requiring repairs. The compressed air is passed into the receivers before mentioned, by a collecting pipe communicating with all the compressors. Up to 1864 these receivers were the only reservoirs for the compressed air, but they were insufficient for the quantity required, especially when any short delay took place in maintaining the supply. It became necessary, therefore, to construct other reservoirs, and two wrought-iron receivers, 164 ft. long and 6 ft. 6 in. diameter, were made, and now stand under the school house and provision store.

When these were made, the regulating reservoir became insufficient, and therefore it would have been necessary to construct a much larger one; but this great expense was avoided by regulating the pressure in the following manner: The consumption of the compressed air, or the working of the perforators was intermittent; during the time of work the consumption was equal to the quantity produced, but in the time of stoppages, the air passed from the

* See ENGINEERING, vol. xi., pp. 347, 377, 421, 429.
† See report of M. Emmanuele Campanela, C.E.

SUBMARINE OPERATIONS AT HELL GATE, NEW YORK.

(*For Description, see opposite Page.*)



compressors into the reservoir, and increased the pressure in them; when this reached six atmospheres, a safety valve in the main, that carried the air along the tunnel, opened, and the air that escaped through it was carried by a tube to ventilate the farthest headings, and this was a very necessary precaution, because, when the mines were exploded, the dense smoke caused by the combustion of the powder rendered the workings untenable. So soon as the boring machines were put into work again, the pressure of course fell, and the safety valve closed. In this manner the pressure was regulated well, and with economy.

The large main that conducted the compressed air to the extreme limits of the heading, was laid along the road, resting on brick pillars, for a length of 6400 ft., to the opening of the tunnel. This main was exposed to all the inclemency of the climate of Bardonnèche, and to variations of temperature ranging from 15° of frost to 104° in the sun. But these violent extremes had no serious effect upon it, although during winter a part of the main was always covered with snow. The tube is 7.84 in. inside diameter, it is .39 in. thick, and is made in lengths of 6 to 8 ft. These were cast with special care, and the joints are made good with compressed gutta-percha.

We may now say a few words about the shops at the entrance of the tunnel. Here are located the forges for repairing and sharpening the boring tools, the blast being obtained from a fan worked by a 10-horse water wheel. There are also workshops to repair the less important damages sustained by the drills, and which saved the trouble of their being removed to the main shops already described. Here, also, is a dwelling-house for the mechanics. Further on is an observatory—a small hexagonal tower, marking the line which passes through the centre of the tunnel, in the centre of which, and standing on a strong foundation, is a theodolite. At the entrance of the yard is the clerk's house, with the offices, and provision stores, general stores, stables, &c. A long shed serves for the carpenters' shops and wagon shelters.

The mortar mills are also here, and near them a small machine for making clay tamps for the blasts; the clay is forced through orifices of the desired size, and is cut off into lengths with wires, and dried. A large ventilator placed over the tunnel entrance drew through a wooden conduit, fixed to the roof of the excavation, the external air replacing it as it was exhausted. This fan was driven by the same wheel that actuated the forge fan; it moved in a horizontal plane, was 19 ft. 8 in. in diameter, and was enclosed within a covered shed.

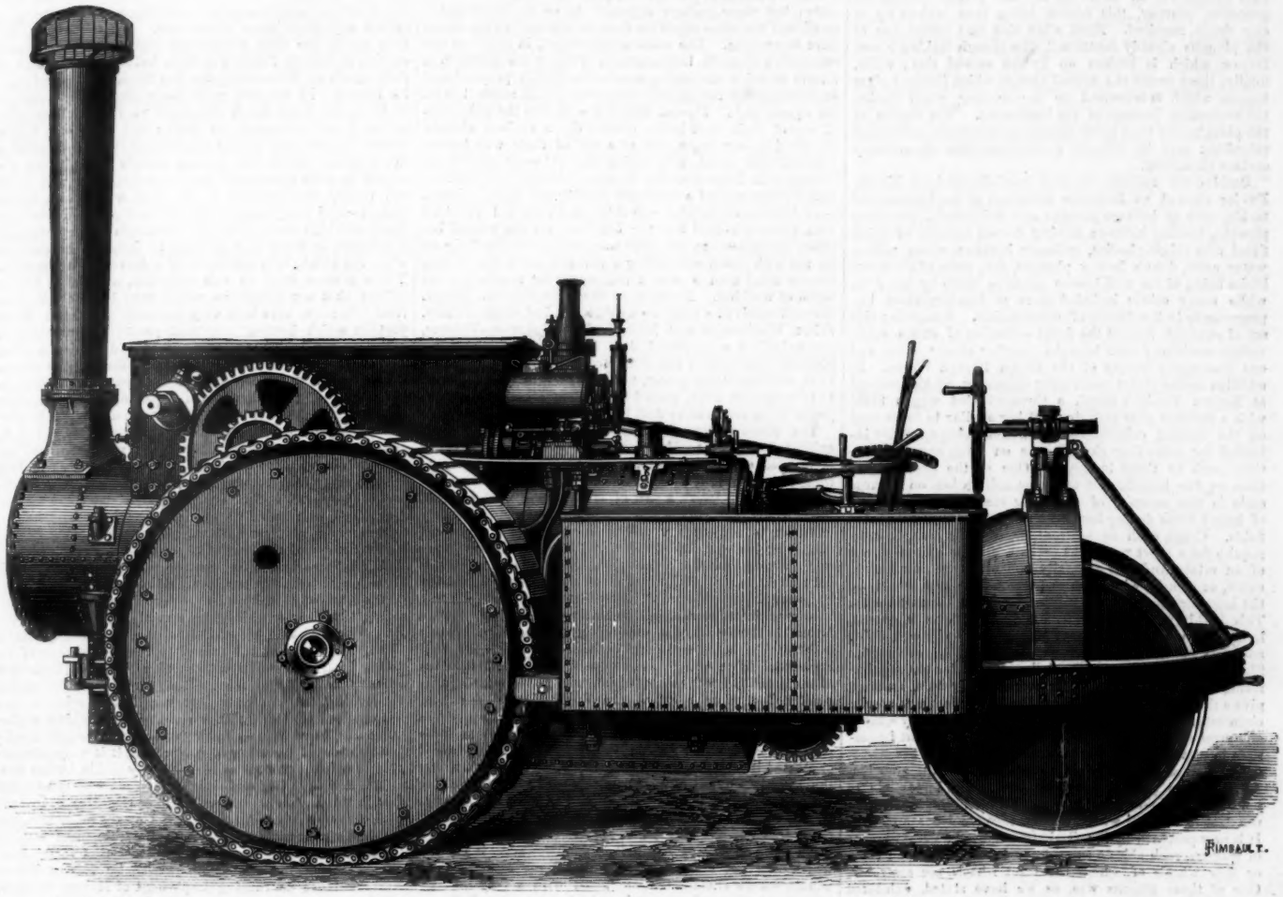
Originally the draught was produced by heated air from an upcast shaft, and though this arrangement answered when the borings had reached no great depth, it became of course entirely inefficient as the work advanced.

FRANCIS KOSSUTH, C.E.,
Royal Commissioner for Railways in Italy.

12-HORSE ROAD STEAMER FOR THE TURKISH GOVERNMENT.

CONSTRUCTED BY MR. CHARLES BURRELL, ENGINEER, THETFORD.

(*For Description, see Page* 41.)

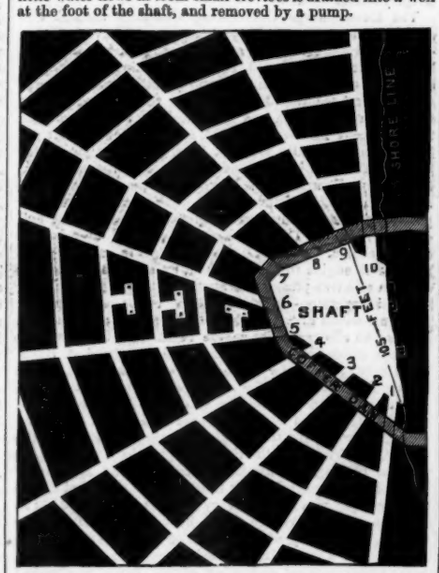


SUBMARINE BLASTING.

FOR many years operations have been steadily pursued in the harbour of New York, to remove the sunken rocks which impede dangerously the navigation; much money has been expended, and many of the obstructions have been removed, one of the most important, known as the Hell Gate, has been worked for more than two years, and various means have been tried in vain to remove it. At last, a system similar to that carried out in San Francisco harbour with the Blossom Rock has been adopted, and regular headings are being driven with the eventual purpose of moving the mass bodily by a gigantic blast. We are indebted to our contemporary, the *Scientific American*, for the following particulars, and the engravings are prepared from drawings which appeared in that journal. The work is making steady, though slow, progress as the rock to be penetrated is principally gneiss streaked with veins of quartz, and is extremely hard to drill. The work now in progress at Hallett's Point contemplates the removal of the whole of the point or reef which now obstructs navigation, leaving a channel of ample depth for the largest vessels with a vertical shore of rock on the land side. To effect this object, a vertical shaft has been sunk within a coffer-dam, one side of the shaft corresponding to a portion of the proposed shore line. From this shaft radiate ten headings as shown in the adjoining sketch, and which have been driven of various lengths from 34 ft. to 80 ft.; the first and tenth headings following the proposed shore line. The headings are to be crossed by galleries, and the piers left standing are to be penetrated by chambers, having a ground plan of the form of the letter T. In these chambers the final charges will be placed and fired, when it is expected the entire mass of rock, left standing after the cuttings, will be broken in pieces of such a size that they can easily be lifted and removed.

The principal portion, in fact, practically the whole of the work, has been done by Cornish miners, imported for the purpose, and with hand drills. The engraving on the opposite page gives an idea of the way in which the works are carried out, and of Severance and Holt's drills employed in boring.

Some inconvenience has been met with during the progress of the work, arising from the inflow of water through fissures. The methods employed for closing such fissures will be of interest to the reader. When the fissure is vertical, holes are drilled along each side of it, at a little distance from its margin. The holes are charged with slow powder, which is simultaneously discharged by an electric battery, the effect being to close the crack. When a horizontal fissure in the wall of a heading is met with, oak wedges are driven into the seams of the strata underlying it, which close it. Other leaks are stopped by means of oakum and cement. What little water flows in from small crevices is drained into a well at the foot of the shaft, and removed by a pump.



The diagrams show the shaft and the headings radiating therefrom, together with the concentric galleries, and the T-shaped chambers, which will ultimately be cut in all the piers. The tunnel headings average 20 ft. in height by 18 ft. in width. The concentric galleries average 16 ft. in height by 10 ft. in width. The shaft is 105 ft. in length by 105 ft. in width, and is sunk to a depth of 32 ft. below mean low-water mark. The engineer in charge of the work is Mr. G. C. Reitheimer, a gentleman of great experience in submarine operations.

THE WOLVERHAMPTON SHOW.

STEAM PLOUGHING ENGINES AND CULTIVATING MACHINERY.

(*Concluded from page* 24.)

CONTINUING our survey of Messrs. John Fowler and Co.'s exhibits, we have next to speak of a ditching machine adapted for being worked by the steam cultivating tackle and capable of digging ditches 2 ft. deep, at the rate of about a mile per hour. The machine consists of a strong frame carried on four wheels, the two front wheels, which are smaller than the others, being provided with suitable steerage gear, while the two hind wheels are mounted on a cranked axle provided with a segment by which it can be turned, the arrangement being similar to that adopted in the turning cultivator, illustrated by us last week. A sheave is fixed at the front end of the implement, and the latter is hauled by passing the wire rope from the engine round this sheave and leading it back to the engine to one of the hind wheels of which it is secured. By this arrangement the engine has a double purchase upon the implement. The sheave just mentioned can communicate its motion, by means of a clutch, to a small winding drum to which there is attached a chain passing over the segment on the hind axle, the arrangement being such that when this chain is wound up on the drum, the hind axle is turned, and by tending to depress the hind wheels lifts the cutting parts of the machine clear of the ground. The ditch-cutting portion of the implement consists of a scoop resembling a pair of large right-hand and left-hand ploughs bolted back to back, this scoop being carried beneath the frame by three very strong colters. When the implement is at work the sides and bottom of the ditch are cut by the two outside colters and the share between them, while the mass of ground is split in two by the central colter and rises slowly to the surface, being placed at some distance at the two sides of the ditch. On reaching the end of its course the cutting part of the machine is raised clear of the ground in the manner already explained, and the implement can then be drawn back to make a fresh cut.

Another implement at Messrs. Fowler's stand, which, although not exactly new, is yet worth noticing here, is the balance subsoil plough for which the firm were awarded a prize. In this plough, which did some capital work at Barnhurst, the frame carries on each side a

pair of ordinary ploughs having Kent breasts which may be set at any depth from 6 in. to 12 in. Besides these, there are also mounted on each half of the frame a couple of deep cultivator tines arranged so that one of them (that which leads) follows the furrow wheel running in an ordinary plough furrow made by the last plough during the preceding journey, this furrow being thus broken up to any depth required. Next after this tine comes one of the ploughs already mentioned, this plough making a new furrow which is broken up by the second tine; while, finally, there comes the second plough which leaves a clear furrow which is traversed by the steering wheel during the succeeding journey of the implement. The depths of the ploughs and tines being adjustable separately a thorough subsoiling may be effected at the same time as ordinary surface ploughing.

Besides the exhibits we have specially noticed, Messrs. Fowler showed an immense collection of implements and tackle, such as balance ploughs and cultivators, trenching ploughs, turning harrows having frames capable of being fitted with ridging bodies, ordinary harrows, steam rollers, water carts, double furrow ploughs, &c., some of these exhibits being of the well-known patterns made by the firm, while many others included more or less important improvements in the details of construction. Altogether this set of exhibits formed the finest collection of steam cultivating machinery ever brought together at any show, and one thoroughly worthy of the Steam Plough Works. In addition to the steam cultivating apparatus, we also noticed at Messrs. Fowler's stand, a three-wheeled wagon fitted with a steerage gear and draught bar similar to those used on the turning cultivators, this wagon being specially intended for collecting the cut cane on large sugar plantations such as those in Egypt. One of the great objections to the introduction of steam cultivation on a large scale is the necessity of providing means for the removal of heavy crops during harvest time from steam cultivated fields. Crops, such as beetroot, or, especially sugar-cane, require for a short period, at present, all the animal power of an estate, and it is generally difficult to see how horses, cattle, or camels, which otherwise would be superseded by the introduction of steam culture, could be dispensed with. This highly important problem is dealt with in a patent, lately taken by Mr. Greig, of Messrs. J. Fowler and Co's., and first brought before the public at the Wolverhampton Show. As his idea is especially adapted for the requirements of sugar estates under steam cultivation, we shall give a short description of its application under these special circumstances. Generally, sugar fields are cut up by ditches and cross ditches to such an extent, that it is almost impossible to move a heavy wagon over the land, and the direct application of traction engines would be out of the question. At the same time it would be practically impossible to handle the sugar-cane twice or three times in its transit from the field to the mill without great inconvenience and loss. It is now proposed by Mr. Greig to construct a great number of wagons, each able to carry 3 or 4 tons of cane, on three or four wheels of which the front wheels are steerable. One of these wagons was, as we have stated, exhibited at Wolverhampton, its steering gear being similar in construction to the well-known front wheel of Fowler and Co.'s turning cultivator. The wagon rests on a turntable, which is carried by the front wheel, the draft stud being placed behind this turntable, so as to give to the steering wheel a leverage over the pull, which it would otherwise not possess. Four or more of these wagons are attached to each other and brought to the field by small traction engines. These never leave the roads which divide the sugar fields, and form as a rule the headlands for the ploughing engines during the time of ploughing. At the two opposite ends of the field which is being cut, two ordinary ploughing engines are placed, their ropes being connected by a shackle, to which a spare chain is fixed. The wagons are attached to this chain and hauled over the field from one engine to the other, being steered along the uncut edge of the sugar cane, and loaded at the same time. Thus the train arrives full at the other end, and is taken away by the traction engine, which in the meantime has walked round the field. Where large central sugar mills are used for several estates, agricultural railways are generally employed to connect the estate with the factory. In this case the sugar wagons worked by the traction engine are provided with a movable cradle, into which the cane is placed in the field. This cradle is lifted by a crane from the wagon and placed on the railway truck, so that even in this case no further handling of the cane is required. The sketch which we give on page 42 shows the operation in the field, and will scarcely require any further explanation. Altogether this is the most practical mode of collecting cut cane by steam power which we have yet seen proposed, and we hope to hear shortly of its being carried out in practice.

Messrs. J. and F. Howard, of Bedford, brought two novelties to Wolverhampton in the shape of a pair of steam ploughing engines fitted with their patent safety boiler. These engines, however, never entered into the competition as—as we have already recorded—they got into difficulties and partially stripped their gearing on the first day of their appearance at Barnhurst. Under these circumstances all we need say about them is that each had a boiler constructed on the same plan as the marine boiler of the Fairy Dell, illustrated on page 155 of our last volume, and that this boiler was mounted towards one end of a wrought-iron frame, while on the same frame, but behind the space devoted to the driver, was arranged the engine proper. The two winding drums were arranged in a vertical position by the side of the engine, their axes running transversely and one drum being behind the other. The ropes from the drums were led out over guide pulleys carried by swivelling arms; but these pulleys appeared to us to be much too small and the arms much too light for the duties they would have to perform. The whole arrangement, in fact, was one susceptible of much improvement, while as we stated on a former occasion the gearing was far too lightly proportioned considering that the engines were worked with steam 180 lb. per square inch. Messrs. Howard were also the exhibitors of one of their cross-boiler double drum engines already described in our pages, and of a set of their well-known "roundabout" tackle with which they did some good work. Amongst the implements for steam cultivation exhibited by this firm we noticed a combined ridging and subsoil plough—an implement forming one ridge at a time and provided with a strong subsoil tine for breaking up the ground between the ridges—an improved corn-drill especially designed for use with steam cultivating apparatus, and a heavy drag harrow fitted with a new arrangement for regulating the depth of working. For each of these implements Messrs. Howard received a prize as we recorded last week. Messrs. Priest, Woolnough, and Michell, of Kingston-on-Thames, also exhibited a combined drill for steam power, this implement consisting of two drills combined in one for drilling 12 ft. wide by steam power, but capable also of being used as two separate drills, each 6 ft. wide, and worked by horse power when required to drill headlands, &c.

The Ravensthorpe Engineering Company, of Mirfield, exhibited sets of tackle constructed on Messrs. Fisken's system, of which we have already spoken. According to these plans the cultivating implement is hauled backwards and forwards between a pair of self-moving anchor windlasses which traverse the opposite headlands, and which may be taken to represent a pair of engines working on the double engine system. These windlasses are driven by a fast running manilla rope $\frac{3}{4}$ in. in diameter, which is led round the plot of land to be cultivated and supported by grooved pulleys carried by wooden standards. Motion is communicated to this rope by leading it round a V-groove formed in the fly-wheel of the engine, and the proper tension is maintained by a straining pulley round which the rope is passed. We shall give in our next number illustrations of the details of this tackle, which will perhaps explain its construction more clearly. In the self-moving anchor windlasses, the gear for driving the winding drum is distinct from that by which the windlass is propelled forward, either gear being capable of being stopped or started independently by means of friction clutches, the throwing into or out of gear being effected without stopping the engine. The windlasses would, we think, be improved by the addition of a simple arrangement of coiling gear, as the practice of allowing a wire rope to coil irregularly on a drum tends to destroy it rapidly; this, however, is a detail which does not affect the principle of the system. The windlasses we should state are fitted with a very neat arrangement of steering gear in which the motion is transmitted from the hand wheel to the leading axle by a pair of epicycloidal wheels.

The Ravensthorpe Engineering Company showed two complete sets of Messrs. Fisken's tackle at Wolverhampton—one set being driven by a portable engine, and the other by a very neatly-designed 10-horse traction engine, constructed by Messrs. Clayton and Shuttleworth. It was with this last-mentioned set of tackle that the competitive trials were carried out, and the excellent results recorded in our recent numbers attained, and it is of it that we intend more especially to speak here. The traction engine had a pair of 7 in. cylinders, with 12 in. stroke, and the effective diameter of the V-groove in the fly-wheel being about 4 ft. 8 in.; it followed that each pound of effective pressure per square inch on the pistons represented a pull on the rope of 11.16 lb. less the amount absorbed in engine friction. Some indicator diagrams in our possession taken with engine running at about an average speed show a mean effective pressure of about 44 lb. per square inch; and this pressure—supposing there to be no losses by friction—would give a strain on the rope of about 491 lb. Making an allowance for engine resistances, the strain on the rope under the circumstances which existed at Barnhurst may probably be taken fairly at about 4 cwt. This is a moderate strain for the rope used, and one under which the latter might probably be employed for a lengthened period. The speed of the rope we ascertained on many occasions during the trials both by timing the speed of the engine, and by noting the time occupied by a splice in the rope in making the complete circuit of the area under cultivation. Ascertained by these means the speed of the "flying rope" was found to vary between 3000 and 3500 ft. per minute, the average speed being about 3200 ft. per minute, thus giving with a strain on the rope of 4 cwt. a mean effective power transmitted through the rope of 43.44 horse power. What proportion of this power is absorbed in driving the rope and windlasses, &c., and what proportion is actually transmitted to the rope hauling the implements it would be impossible to ascertain exactly without the aid of a dynamometer on the latter; but judging from the amount of work done in proportion to the power developed by the engine, and comparing it with that done by engines working on the other systems, there is good reason for believing that the friction of tackle arranged on Messrs. Fisken's plan is very far from being excessive. This view is, we understand, supported by indicator diagrams taken from the engine when the tackle was running "light"—that is, driving the windlasses but not hauling an implement—but as we have not ourselves had an opportunity of inspecting these diagrams, we cannot say more about them here. We candidly admit that we at one time entertained but a very indifferent opinion of Messrs. Fisken's system, but the performance of their tackle at Woverhampton has much predisposed us in its favour. In common with many others who witnessed its trials, we were much surprised at the quickness with which it was arranged for work; and it is only fair to Messrs. Fisken that special attention should be directed to the facilities which the system affords for placing the engine in some convenient position where fuel and water can readily be conveyed to it. The weak point in the system—and every system has its weak point—is the high speed at which many of the parts are driven, a speed which it is feared by some may give rise to frequent breakdowns when the tackle is in the hands of ordinary farm labourers. There is some force in this objection, no doubt; but we believe that any difficulties which may be likely to arise from this cause have been very generally overrated. Those parts in which heating may most probably be expected to occur are the bearings of the corner and tension pulleys, and of the high speed parts of the windlasses. At present the corner and tension pulleys used are about 20 in. in diameter, and they thus make about 640 revolutions per minute when the rope is passing over them; but this speed can readily be reduced to one-half if found necessary, by simply increasing the diameter of the pulleys proportionately. The spindles of these corner pulleys run in long sockets containing the bearings, and charged with tallow, and they appear, as far as can be judged from the trials at Barnhurst, to require no special attention. The moving parts of each windlass have the advantage of being directly under the eye of the man in charge, and with ordinary care and good workmanship, we see no reason why trouble should arise from hot bearings. It is true that during one of the trials at Barnhurst, a bearing of one of the windlasses did get hot, and ultimately caused a failure; but this failure can scarcely be said to be due to the hot bearing alone, but more to the fact that those in charge of the tackle decided to continue the trial, and risk a breakdown, rather than stop and take effective measures for cooling the bearing. A similar failure might have arisen from a hot crank-shaft bearing in an ordinary ploughing engine. Of course, in really careless hands the tackle would stand a good chance of "coming to grief;" but it is very unprofitable to employ careless hands with any tackle, and all users of steam-cultivating machinery would do well to bear this fact in mind. Altogether, we consider that Messrs. Fisken's tackle, thoroughly well merited the award made to it, and we shall watch its further practical development with interest. In conclusion, we should state that there are no special features in the implements used by Messrs. Fisken, either balance or turning implement of Messrs. Fowler or other makers being used as may be found desirable.

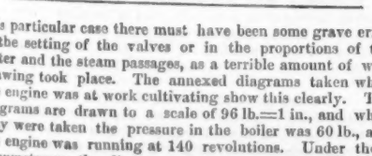
Messrs. Amies and Barford, of Peterborough, exhibited a set of "roundabout" tackle with Campain's patent self-moving anchors, of which we have already spoken, and a sketch of which appeared in this journal on page 381 of our eighth volume. Since the publication of that sketch, however, the construction of the apparatus has been simplified, and we hope shortly to illustrate it in its present form. Meanwhile we may describe it briefly. Each anchor, then, consists of a wooden frame mounted on four disc wheels of the usual moving anchor pattern, and carrying the pulley round which the hauling rope is passed. One of the axles is capable of being turned on a centre for the purpose of steering the anchor; while on the other, or hind axle, are fixed two or more sets of cross tines, which sink into the ground as the axle revolves. These tines used formerly to be mounted on a separate axle, but the present arrangement is not only more simple, but is found to be preferable in other respects. The anchors being situated at the corners of the plot under cultivation, most distant from the engine, the pull of the rope tends to move them forward, and this tendency is resisted by the tines on the hind axle, that axle being prevented from revolving by a suitable ratchet arrangement. When it is required to shift the anchor forward, however, the axle is released, and it then turns until again checked by the ratchet, thus allowing the requisite forward motion. The arrangement is one saving much labour, and throughout the trials it performed admirably without a single failure or hitch of any kind.

Messrs. Amies and Barford's tackle was driven by a traction engine, built by Messrs. Tuxford and Sons, this engine being coupled to a windlass constructed by the same firm. Of Messrs. Tuxford's engine we have already spoken; but of the windlass, which was subsequently exhibited at their stand, and which was undoubtedly the best apparatus of its class on the ground, we must give some particulars here. The windlass, then, consists of two rope drums mounted on an axis, which also carries a spur wheel driven by a pinion on the belt pulley shaft in the usual way. Each winding drum is capable of being connected to the drum shaft by means of a set of three toggle arms, which can be expanded radially, and which when thus expanded force three cast-iron blocks into contact with the turned inner periphery of the drum, thus driving the latter by

friction. The toggle arms are expanded and contracted by a screw traversing the winding drum shaft, the arrangement being such that one set of arms is expanded when the other is contracted, and *vice versâ*. Thus either drum can be connected or disconnected at pleasure, and the arrangement possesses the important advantage of enabling the windlass man to stop or start the implement at any time without interfering with the engine. In addition to the frictional starting and stopping gear, each winding drum is also provided with a simple automatic brake for the purpose of checking its motion while the rope is being payed off. This brake consists of a wrought-iron strap placed around a suitable part of the drum, and having its ends connected to a short lever, which vibrates on a fulcrum fixed to the frame of the windlass. That end of the brake strap proceeding from the lower side of the drum is coupled to the end of this lever, while the other end is coupled to the latter at a point intermediate between the end and the fulcrum. When the tail rope is being hauled off a drum the latter revolves in such a direction that the side next the fulcrum just mentioned rises; and, the brake strap being partially carried round with it, the manner in which the strap is coupled to the lever, gives rise to a tightening action. This brake action is automatic, the brake being at once applied to either drum, on the latter commencing to pay off the tail rope, while the drum can be at once set free if desired by the attendants simply raising the outer end of the brake lever. The whole arrangement acts admirably in practice, and is a very convenient one.

Before leaving Messrs. Amies and Barford's steam ploughing tackle, we must mention two or three implements intended to be used with it, which are worthy of special notice. One of these is the press wheel roller illustrated by us on page 43, and for which the firm were awarded a prize. This roller is 7 ft. 6 in. long by 3 ft. in diameter, and it is fitted with a simple but powerful steerage for turning at the headlands. Its general construction will be evident from the engraving without further explanation. Another good implement was a set of drag harrows, constructed on a plan invented by Mr. J. Osler, of Walrond Park. This set of harrows consists of three plain triangular frames, two of these frames being arranged side by side with their bases in a line with each other, while the third is placed in front, the two extremities of its base being linked to the apices of the two frames first mentioned. The tines are fixed along the sides of the triangular frames, and the distance between them can thus be readily adjusted, while the whole arrangement gives great flexibility. For travelling one of the frames is mounted on wheels, while the others are packed compactly on the top of it. The harrows are fitted with a simple arrangement for steering and turning at the headlands, and the tines can thus be made of a curved form, an important advantage. The ploughs and cultivators supplied with their tackle by Messrs. Amies and Barford are also of good patterns, but they require no special description. Their portable wire-rope tarring machine, also, is very well adapted for dressing the wire ropes used in steam cultivation. It simply consists of cleaning brushes and of a furnace, with a trough containing the composition, which can be applied in the heated state in the open air. The last implement of Messrs. Amies and Barford's we wish to refer to here is an improved rope porter for steam cultivation, made of tubular iron. In this porter, instead of the usual fork arrangement being employed, the rope is picked up and guided by a wheel, which can slide along a spindle, fixed at right angles to and above the carrying wheels.

Messrs. Barrows and Stewart, of Banbury, exhibited a set of "roundabout" steam cultivating tackle with which some very good work was done at Barnhurst. The windlass of the tackle is of a very simple and substantial pattern, but it includes no features requiring special notice. During the trials it was driven by one of Messrs. Barrows and Stewart's double-cylinder engines with 8½ in. cylinders and 13 in. stroke. We have always been admirers of the design of Messrs. Barrows and Stewart's engines; but in



this particular case there must have been some grave error in the setting of the valves or in the proportions of the latter and the steam passages, as a terrible amount of wire drawing took place. The annexed diagrams taken when the engine was at work cultivating show this clearly. The diagrams are drawn to a scale of 96 lb.=1 in., and when they were taken the pressure in the boiler was 60 lb., and the engine was running at 140 revolutions. Under these circumstances the diagrams show a maximum pressure in the cylinder during one stroke of but 42 lb., and during the other of but 36 lb. only, while even those pressures, it will be noticed, are not attained until a considerable length of each stroke is performed. The back pressure, too, for the greater part of the length of the stroke is over 5 lb. per square inch. It is possible, certainly, that these defects may have been somewhat exaggerated by throttling in the indicator pipes; but at the moderate speed at which the engine was being run when the diagrams were taken, we do not think any great effect is to be traced to this cause unless, indeed, the throttling was most excessive. However this may be, it is certain that the diagrams, as they stand, are very bad indeed.

Mr. Edward Hayes, of Stoney Stratford, exhibited a set of tackle for working on the "roundabout" system on which much ingenuity had no doubt been expended, but which failed utterly when tried by the judges at Barnhurst. Mr. Hayes's windlass, instead of being driven by a connecting shaft, with universal joints, according to the general plan, was worked by a belt led from a very wide drum fixed to the crank shaft of the engine outside the fly-wheel, the great overhang of this drum rendering the arrangement a most unmechanical one. The windlass has three belt pulleys, one for driving each drum, and a loose pulley between them, while it is also provided with a steam brake, arranged so that the act of shifting the belt on to the loose pulley causes the brake to be applied to both the drum pulleys. Mr. Hayes also included amongst his tackle some self-moving anchors—in which the rope pulley was far too high above the ground level—and which were found in practice to yield from that cause, and also new forms of snatch block and rope porters, which it is unnecessary for us to describe here.

Mr. John Tenwick, of Grantham, whose annealing oven we illustrated a short time since, exhibited, besides some other things, which we shall notice in their proper place, a self-adjusting pulley for steam ploughing and cultivation. The pulley is mounted on a central ball-joint, so that, when lifting a weight, or when acting as a guide pulley, it can be readily set to such an angle that the rope may lead fairly to it, and when thus set it can be secured in position by a suitable cap placed over the spherical bearing. The steam cultivating anchors constructed on this plan, and exhibited at Mr. Tenwick's stand, appeared as if the pulley would be carried too high above the ground level for proper stability; but we were informed by Mr. Tenwick that they were intended to be well buried, so as to keep the pulley down low, and Mr. Tenwick, moreover, recommends that in the case of farms on which the roundabout system of cultivation is in regular use, the spindles or stands for the fixed anchor pulleys should be permanently bedded in concrete in their proper positions in the several fields. Where the tracts of land cultivated without shifting the engine and windlass are large this plan, if carried out, would involve but a comparatively small additional first cost, and it would undoubtedly save time in getting to work and the trouble resulting from the main anchors yielding.

Mr. James Coultas, of Grantham, exhibited, amongst other things, an 8 ft. 6 in. 14-row corn and seed drill for steam power, fitted with Fowler's fore steerage. This was a well-designed implement, which was stated to have been successfully worked all the spring upon every description of soil. Another exhibitor of new implements to be worked by steam tackle was Mr. John Allin Williams, of Baydon, who showed and submitted to trial a combined roller, cultivator, and set of three harrows. In this implement the cultivator—which could be lifted when a turn was to be made—was arranged behind the roller, and was, in its turn, followed by the harrows.

Traction Engines.

Of most of the traction engines shown at Wolverhampton we have already given particulars, and of this class of exhibits, therefore, we shall have to speak but briefly here. Messrs. Aveling and Porter, of Rochester, in addition to their three competitive engines already described by us, showed a 12-horse ploughing engine, one of a pair intended to work on the double-engine system. This engine should perhaps have been included amongst the exhibits noticed by us above, but as it was shown without its winding drum, and was regularly employed as a traction engine during part of the meeting, we have chosen to include it in the present class. We should mention that the engines constructed by Messrs. Aveling and Porter for working on the double engine system are built right and left-handed, the arrangement being such that the rope is always led from that side of the winding drum towards which the driving pinion is situated. The effect of this is that the centre pin on which the drum is mounted has to bear a strain equal only to the difference between the strain on the rope and the driving pressure of the pinion, and it is thus subjected to much less wear than when the rope is led off from the opposite side to the pinion, as is the case with one engine of each pair constructed in the ordinary way. In the engine of which we are now speaking, the road gear is driven by a pitch chain, and the design and workmanship are good throughout. The same makers also showed one of their useful 15-ton steam road rollers, which have already been described in our pages, and the employment of which is, we are glad to say, rapidly extending.

Mr. Charles Burrell, of Thetford, in addition to the 8-horse traction engine and the 8-horse Thomson road steamer which were tested on the brake, exhibited, during the later days of the show, a 12-horse road steamer of a new pattern constructed by him for the Turkish Government. This engine, of which we publish an engraving on page 39, has a boiler of the locomotive type, this boiler being balanced on the driving axle and being capable of being raised or lowered at the firebox end by means of a rack, pinion, and worm wheel, so that its axis may be kept horizontal whatever may be the incline of the road on which the engine is working. The boiler has 26 square feet of firebox surface and 205 square feet of tube surface, making 231 square feet in all. The engine has two cylinders, each 7¼ in. in diameter by 10 in. stroke, these cylinders being fixed at the top of the boiler near the firebox end as shown. The crank shaft is of wrought iron with the eccentrics forged in one piece with it, and a steel countershaft is provided to obtain two speeds. The gearing is throughout made of McHaffie's cast malleable iron. The driving wheels are 6 ft. in diameter and are fitted with Thomson's india-rubber tyres 14 in. wide, while the two leading wheels, which are situated but a short distance apart, are 4 ft. 2 in. in diameter and have rigid tyres 7½ in. wide. The load is transmitted to the axle of these wheels by a spring. The water tank is arranged under the boiler and will hold about 250 gallons, while the coal bunker is at the front end by the side of the steersman. The weight of the engine is stated to be 8 tons. We like the general arrangement of this engine and we believe that it will be found to answer well; but we expect that in practice the appliances for inclining the boiler with respect to the frame will be very little used unless indeed the engine has to work on an unusually long continuous gradient. The fact is, that unless there are glass water gauges at each end of the boiler and the man in charge is capable of seeing both these gauges at once there is always a strong chance of more harm than good being done by attempts to incline the boiler. In an engine intended to work over rapidly rising and falling ground we should have ourselves preferred to get over the difficulty of variations of water level by using a very short boiler rather than by resorting to any gear for inclining it. Short boilers can be made to work just as economically as long ones if the diameter of the tubes is suitably proportioned to their length.

Messrs. Maude and Walker, of Shrewsbury, were the exhibitors of a wonderful specimen of traction engine building, which may possibly have been sent by its makers as an example of "how *not* to do it." Judging from the few eccentric evolutions made by this engine in getting into position, it possessed a strong will of its own, which the mechanical apparatus at the command of the driver were insufficient to enable him to control. As an instance of these appliances, we may mention that the valve was driven by a single eccentric having a bevel wheel attached to it, and the reversing was performed by the driver, more or less skilfully, getting a pinion into gear with this bevel wheel, and thus turning the eccentric on the crank shaft! Altogether the engine ought to have been seen to be appreciated, and we shall not, therefore, attempt to describe it further.

Messrs. Robey and Co. intended to have exhibited a Thomson road steamer, and Messrs. Ruston, Proctor, and Co. a road steamer fitted with Nairn's elastic tyres, but both these exhibits made their appearance in the catalogue only.

Portable and Fixed Engines.

No striking novelties were to be found in this class of exhibits at Wolverhampton, and even minor improvements in constructive details were rare. Messrs. Clayton and Shuttleworth had, as usual, an admirable show of engines at their stand, but in one of these engines only did we notice any novelties of construction. This engine had crank-shaft brackets of a new and very neat design, while it was also fitted with a disc balance weight applied to one side of the crank, and with an exceedingly compact arrangement of feed-water heater. This disc balance weight, we are sorry to say, looks clumsy, and we doubt whether it possesses any practical advantage sufficient to make up for its want of beauty. The feed-water heater is constructed on the plan of leading a jet of steam from the exhaust into the overflow pipe or passage through which excess of water from the pump passes back into the feed tub. The details of the arrangement are worked out in an exceedingly neat way, well worthy of a word of praise. Messrs. Clayton and Shuttleworth's exhibits include the 10-horse fixed engine which gained first honours at Oxford last year, and also an 8-horse fixed engine of a somewhat similar pattern. Both these engines were admirable examples of the highest class of engineering workmanship.

Messrs. Marshall, Sons, and Co., of Gainsborough; Messrs. Robey and Co., and Messrs. Ruston, Proctor, and Co., all had good shows of well-made engines of their usual patterns, but we noticed nothing new in engine-building at either of these stands, except a neat form of connecting rod large end employed in their 3-horse vertical engine by the last-mentioned firm. This end is of the strap pattern, but the butt is cut out, so as to form a recess, in which an oil-cup attached to the upper half of the brass bearing stands. The arrangement is a convenient one for vertical engines, and we expect to see it copied at next year's show.

Among the exhibits of the Reading Iron Works Company, Limited, were some horizontal fixed steam engines of good design and workmanship, representing the different series of engines now manufactured by this firm. We should state here that, as regards first cost, these makers have found it convenient to classify their engines into two classes, A and B, the former comprising engines fitted with all the special appliances to produce economical working, while the engines of the second class are of a simpler construction, and of plainer finish, which, of course, admits of a considerable reduction in price. It is unnecessary that we should describe the ordinary patterns of engines constructed by these makers, as they are now well known, but we should state that since the last show at Oxford the Reading Iron Works Company have introduced a new

series of small horizontal fixed engines of very neat design, and of these engines two samples—a 1-horse and a 2-horse—were exhibited at Wolverhampton. These small engines are self-contained on a strong and rigid bed-plate, this latter forming, with the front cylinder cover and the plummer blocks for the crank-shaft bearings, one single casting, to the end of which the cylinder is secured. The engines are also fitted with a neat form of high-speed governor. One advantage due to their general arrangement is the ease with which they can be fixed; they can, in fact, be placed on any floor without masonry, while their compactness and stiffness admit of high working speeds without any fear of greatly increased wear and tear.

Messrs. Ransomes, Sims and Head, of Ipswich, showed nothing new in portables this year, but the engines they did exhibit were examples of thoroughly good workmanship. Messrs. Tuxford and Sons also adhered to their well-known patterns, and showed a large collection of the engines of the various types made by them, including some of their steeple and inverted cylinder engines with return tube boilers.

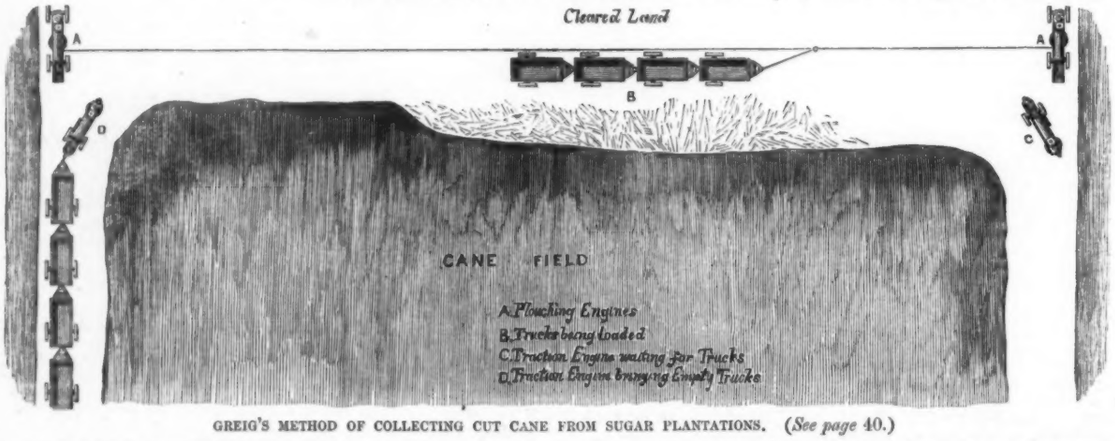
Mr. Uriah Nicholls, of Manchester, exhibited a combined vertical engine and boiler which was compact and well made, but which possessed the objectionable feature of the crank shaft being passed through a tube which traversed the boiler, the result being that in order to do anything to the crank shaft bearings either the fly-wheel or the crank has to be taken off and the shaft withdrawn endways. The last engines we shall notice here are the queer little oscillating engines shown by Mr. Joseph Davies, of Wednesbury, and these we notice, not because we admire them, but because we feel some curiosity as to the amount of steam they would devour per horse power per hour. We should like to see one tried on the brake. But we suppose that when a two-horse engine with feed-pump, governor, &c., complete is offered for 14*l.* 10s., we must expect it to possess a good appetite for coal and water.

Of boilers built up in sections, there were three exhibitors. First, Messrs. Howard showed examples of their well-known safety boilers, one with vertical, and the other with horizontal tubes. The latter requires no brick setting, and in the example exhibited the end joints of the tubes were made in a very simple way. Next, the Patent Steam Boiler Company, of Birmingham, showed a 30-horse boiler, constructed on Mr. Root's plan, described by us on page 102 of our ninth volume; and, lastly, the Isca Foundry Company exhibited one of Miller's cast-iron boilers, of which we published an illustrated account on page 488 of our sixth volume. This last-mentioned boiler was shown fitted with Berryman's water regulator, illustrated and described by us in our last number.

Mr. William Taylor, of Birmingham, exhibited several sets of Martin's Argand firebars. These bars are cast of iron specially suited for the purpose, and they are provided with numerous air passages which, it is claimed, render the bars lighter and, at the same time, more durable than ordinary firebars.

drill, invented by Mr. W. Randall, of the same place, which, after being thrown out of gear, can be quite raised for turning. In one form of the machine the lifting is done by eccentrics on the driving axle. The implement has a very simple lever steerage, and it is arranged so that all the weight can be thrown upon the coulters if necessary. In speaking of drills, also, we should mention a simple "drill-setting board" exhibited by Messrs. William Walker and Son, of Tithley. This is simply a board having the extreme width of the drill marked on it, and having the intermediate space divided out by lines numbered to correspond to the number of drills to which they refer. Thus four of the lines are marked "4," to show that they indicate the positions of the drills when four are in use, while five other lines are marked "5," and so on. This board appears to be a handy little contrivance, calculated to save much trouble in setting the drills.

Mr. Lewis Wright, of Hannah, Alford, was the exhibitor of a very ingenious self-ridging potato drill, designed by him, and made by Mr. Thomas Ashby, of Louth. In this implement the seed potatoes, whether whole or cut, are



GREIG'S METHOD OF COLLECTING CUT CANE FROM SUGAR PLANTATIONS. (*See page* 40.)

Messrs. E. R. and F. Turner, of Ipswich, showed a portable engine fitted with the piston valves and arrangement of self-adjusting expansion gear illustrated by us on page 464 of our tenth volume. Messrs. Tangye Brothers and Holman exhibited examples of their very neatly designed stationary engines which have already been illustrated in our pages and they also showed a number of their well-known "special" steam pumps. One of these pumps is now at work at Messrs. J. Pease and Company's colliery at Bishop Auckland, where it is raising 120 gallons per minute on the enormous lift of 1048 ft. This pump has a steam cylinder 26 in. and a pump cylinder 6½ in. in diameter, the stroke in both cases being 6 ft. Messrs. Hayward Tyler and Company also showed, amongst a variety of other things, a collection of their "universal" steam pumps, of the construction and performance of which we have had occasion to speak favourably on former occasions.

Messrs. Brown and May have to be included amongst the makers who adhered to their ordinary patterns, but we must bestow a word of commendation on their vertical engines, which are provided with ample boiler power and are altogether a very good job. Some other very well made vertical engines were exhibited by Messrs. Davey, Paxman, and Company, of Colchester, these engines being fitted with the Davey-Paxman boiler, of the construction and performance of which we gave a full account on page 273 of our tenth volume. During the Wolverhampton show one of these boilers was exhibited at work with the manhole cover removed, and the thoroughness of the circulation together with the efficiency of the deflectors at the top of the water tubes in preventing the rising current of water from being projected into the steam space were very clearly seen. For the sake of illustration some of the tubes were worked without deflectors, and the contrast was very remarkable. The more we see of this boiler the more we like it.

Mr. W. S. Underhill, of Newport, showed three engines fitted with the form of slide valve applied by him to his competing engine at Oxford last year, this slide valve forming a kind of moving steam chest, and carrying with it the throttle valve. The effect of the arrangement is that there is very little steam space between the throttle valve and the cylinder, and any movement of the throttle valve thus affects the engine with great promptness. Messrs. Ashby, Jeffery, and Luke, of Stamford, showed some very neat portable vertical engines mounted on three wheels large enough for travelling on the road, the front wheel being fitted to a turntable frame. The platform on which the boiler stands forms the feed-water tank, and the general arrangement and design are good. We understand that it was the intention of this firm to have exhibited and submitted for trial a traction engine with wooden wheels constructed on a new plan, but they were not able to get it completed in time. A very neat and well made little vertical engine was also exhibited by Messrs. Riches and Watts, of Norwich.

Field Implements.

Of ploughs, Messrs. J. and F. Howard had, as usual, an extensive show, including several new patterns. One of these was a plough having a wheel behind, thus avoiding the use of a slade, and its consequent friction. A second was a turnover plough, having hind wheels, and being made to be guided by a man walking by the side of it; while there were also new forms of turn-wrest, and double-furrow ploughs, and a three-furrow plough, fitted with a seat for the ploughman, and convenient steerage. We noticed, also, that Messrs. Howard are now making their harrows with the frame bars of a H section, a form which gives great rigidity combined with lightness.

Messrs. Ransomes, Sims, and Head, of Ipswich, were also large exhibitors of ploughs, and we noticed at their stand a very light double-furrow plough, well adapted for light soils, a new double-furrow ridging plough, with a well-contrived lifting and turning apparatus, and some other very useful and well-made implements.

The greatest novelty in the way of ploughs, however, was the American revolving mould-board plough, exhibited by Mellard's Trent Foundry, Limited, and we believe was first shown by them at the last Smithfield Club Show. In this plough the ordinary mould board is replaced by a revolving disc, the action of which is stated to make the operation of the plough more like digging than ploughing. A great variety of ploughs constructed on this plan, and applicable to different purposes, were exhibited, and some excellent work was done by the implement during some trials at Barnhurst.

Messrs. Coleman and Morton, of Chelmsford, were one of the few firms who exhibited implements for hop cultivation, and we noticed at their stand a light cultivator with seven tines, and a neat arrangement of hop-syringing engine, for which latter they received a prize. This engine consisted simply of an iron barrel mounted on high wheels, and fitted with a good pump provided with an air vessel, so that a steady stream could be delivered on the plants.

Mr. George Holdom, of Bletchley Iron Works, Fenny Stratford, was the exhibitor of a very good corn and seed

Of the mowing and reaping machines exhibited, we shall speak but briefly, as there were no novelties calling for a detailed description here. Messrs. Howard showed their now well-known "International" reaper and "British" mower, one of the latter being fitted with an arrangement for specially adapting the machine to very uneven ground, which, we believe, was first exhibited by the firm at the last Smithfield Club Show. The Reading Iron Works Company also showed mowers of their usual patterns, as did also Messrs. Samuelson and Co., of Banbury, the latter firm having a very good and extensive collection of exhibits in this class. Mr. A. C. Bamlett, of Thirsk, showed some reapers in which some new features had been introduced, but cannot say we admired them, and we have no space to describe them here. Messrs. Hunt and Pickering, of Leicester, also exhibited mowing and reaping machines, with some new points of detail about them, and the same may also be said of the mowers and reapers exhibited by Messrs. Picksley, Sims, and Co. (Limited), of Manchester, Mr. Walter A. Wood, and Messrs. Burgess and Key, of London.

Mr. John Tenwick, of Grantham, exhibited examples illustrating his plan of constructing the cutting parts of reaping and mowing machines by using hardened steel jaws as mouthpieces for the knives to work against, similar to the mouthpiece of chaff cutters. The knives are bevelled on the top and bottom sides, thus forming a cutting edge on the bottom part of the finger as well as on the top part of the thumb, while this latter is also made to answer the double purpose of a knife guide and finger. Mr. William Ashton, of Horncastle, was the exhibitor of a "chisel-tooth" harrow, having teeth with points of a peculiar form, and fitted with lifting gear for regulating the depth of cut. This harrow can, by means of this gear, be raised on its wheels completely clear of the ground for travelling on the road.

Thrashing Machines, Screens, &c.

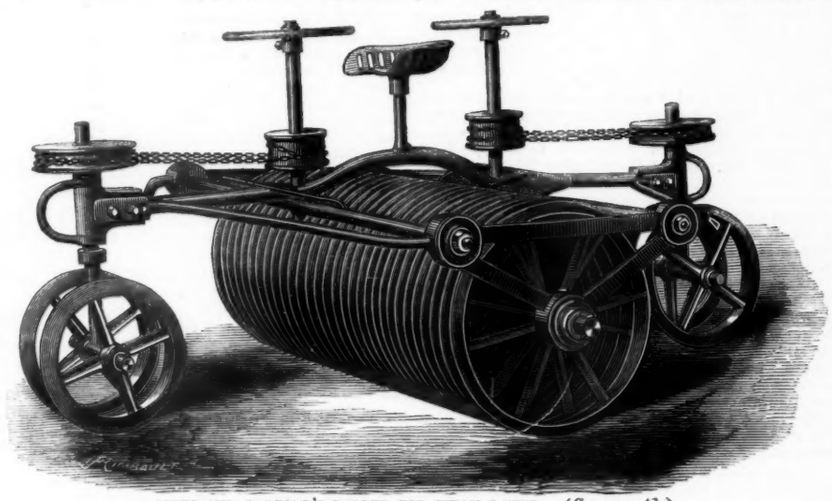
In thrashing machines the most noticeable feature was the introduction of trussed frames by two of the makers, and the increased employment of adjustable screws, such as Penney's and Rainforth's. Thus Messrs. Clayton and Shuttleworth are now making their machines with side frames having two diagonal bars inclining upwards from the ends, and almost meeting at the centre, the whole forming a frame somewhat resembling a roof principal with two king posts. This arrangement gives great rigidity, enables the bottom bar of the frame to be materially lightened,

placed in a box, from which they are taken one by one by endless chains, having links of such a shape as to form a series of cups. These chains deliver the potatoes to the tubes which deposit them, while other tubes are provided for manuring. The machine, in fact, performs ridging, setting, manuring, and covering at one operation. The details of the implement are exceedingly well worked out, and there is nothing complicated about it.

and altogether makes a thoroughly good job. Messrs. Ruston, Proctor, and Co., also show thrashing machines with trussed frames; but instead of employing diagonal frame bars as is done by Messrs. Clayton and Shuttleworth, they make the diagonal trusses of light half-round iron, these trusses, like Messrs. Clayton and Shuttleworth's, extending upwards from the ends towards the centre. The half-round bars are of course under these circumstances in compression, but the fact of their crossing and being secured to the other framing does away with any chance of their buckling. Messrs. Robey and Co., exhibited specimens of their machines with iron frames, which we have had occasion to commend on previous occasions, and other makers adhered in almost all cases to their usual patterns.

Among a number of implements exhibited by Mr. Boby, of Bury St. Edmund's, we noted an ingenious self-acting corn screen. Mr. Boby makes these machines to screen from about 80 to 200 bushels per hour, and the cleaning apparatus is rendered self-acting in the following manner. The grain in passing from the hopper to the screen causes to revolve, by its weight, an overshot or breast wheel placed in a convenient position. The motion thus imparted to this wheel is then transmitted by means of cranks and rods to the cleaning collars between the wires of the screen, and the screen is thus kept free from substances, which would otherwise collect in them and render them useless. The apparatus is specially adapted for a hanging screen when the grain is supplied to the hopper from the floor above, but it may also be arranged on the floor and the hopper filled in the usual way. In either case the machine has the advantage of requiring no manual labour to keep it clear.

In elevators we notice two novelties, the one being the folding balance elevator exhibited by Messrs. Tasker and Son, of Andover, and the other the slow-motion auto-



AMIES AND BARFORD'S ROLLER FOR STEAM POWER. (*See page* 41.)

matic folding elevator made by Messrs. Wallis and Steevens, of Basingstoke. Messrs. Tasker and Son's elevator is mounted on a single pair of well-made wrought-iron wheels, 5 ft. in diameter, and it is contrived so that when folded for travelling it balances well on these wheels. The arrangements for opening and folding are simple and efficacious, and the whole is a very good job. Messrs. Wallis and Steevens's elevator is also a good implement, and the automatic folding apparatus is ingeniously contrived. It would, however, be impossible for us to describe its arrangement clearly without the aid of drawings.

Mills and Grinding, Crushing, and Cutting Machinery.

In mills, a decided departure from ordinary practice was exhibited in Mr. Edward Evans's vertical mill, shown by the maker, Mr. George Parsons, of Martock. Many of our readers will remember Mr. Evans's mill—in which the stones run in a vertical instead of a horizontal plane—being exhibited at the Manchester show; but since that time many improvements have been made in its details, and that shown at Wolverhampton was a very neat and compact looking machine. Mr. Evans's plans have undoubtedly much that is good about them; but as we intend shortly to illustrate his mill as now made, we shall not enter into details concerning them here.

In the ordinary corn mills exhibited at Wolverhampton, almost all the makers had adhered to their regular patterns. Messrs. Clayton and Shuttleworth, however, we noticed, had adopted the new, and very good form of framing, illustrated by us on page 139 of our last volume, for their double as well as their single mills.

Messrs. Oldham and Booth, of Kingston-upon-Hull, showed a new bone-dust mill intended for reducing to dust the $\frac{1}{2}$ in. bones which have passed through an ordinary mill. The machine, which is well made, consists simply of a pair of serrated rollers, between which the crushed bone is passed. Close to the above-mentioned exhibit, also, Messrs. Hamilton Woods and Co., of Salford, showed a very neat little self-contained malt mill, with screen, &c., suitable for small breweries, and well worthy of a word of commendation.

Mr. H. R. Marsden, of Leeds, showed his useful stone-breaking machine, at work as usual, the leading novelty at his stand being the machine with curved jaw, illustrated and described by us in our last number. This stone-breaker, by the way, was exhibited fixed on a wooden frame with a vertical engine for driving it, the whole being mounted on wheels for convenience of transport. The Dunston Engine Works Company also showed a new arrangement of Archer's stone-breaking machine, in which the stones are crushed between a revolving roller and reciprocating jaw, the roller being fluted horizontally and the jaw vertically. The machine exhibited at Wolverhampton was fitted with an elevator for raising the broken stone into a hopper, from which it could be discharged into carts, one side of this hopper being perforated to form a screw. The idea of raising the broken stone in this way is good, but in the particular machine exhibited, the screening surface of the hopper was too short to be thoroughly efficient.

Close to the above machine Messrs. Atkin and Sons, of Birmingham, exhibited in action their bone and hoof-sawing machine, this machine consisting of a box in which the bones or hoofs to be reduced to dust are placed, and from which they are thrust out, by a kind of piston, against a series of circular saws placed close together side by side. These machines appear to do their work effectively. In the same range of shedding, also, Messrs. Brown and May showed Norton and Hawksley's grinding and disintegrating mill, in which the operation of grinding is performed by the percussive action of rapidly-revolving flyers or beating arms. These mills appear to be capable of turning out a large quantity of work, and they are suitable for reducing a great variety of materials.

Amongst the chaff-cutters exhibited those constructed by Messrs. Ashby, Jeffery, and Luke, of Stamford, are worthy of special mention. The new chaff-cutters of these makers are built upon a strong and firm wrought-iron foundation frame, and are mounted upon lifts of angle iron, the whole being a good strong job. The gearing also is well protected by a casing. Messrs. Southwell and Co., of Rugeley, also had some new chaff-cutters of a good pattern; the same firm also exhibited a new form of grist mill, in which the "concave," between which and the serrated drum the corn to be ground passes, is held up in its place by a weighted lever, the intention being that the concave shall yield in the event of any hard substance which cannot be ground being inadvertently passed through the mill. We are very doubtful, however, about the concave being able to yield with sufficient promptness to prevent damage. The drum and concave are chilled castings, and it is stated that the grinding surfaces can be re-sharpened and brought to a true face by running a little fine sand or emery through the mill. Messrs. Richmond and Chandler, of Salford, also showed a chaff-cutter adapted for cutting two lengths, one of the knives being adjusted to a loose plate, which may be attached and removed at pleasure, according to whether a $\frac{3}{8}$ in. or a $\frac{3}{4}$ in. cut is desired; and Messrs. Picksley, Sims, and Co., of Manchester, exhibited, besides some good chaff-cutters and root-pulpers, a treble-action turnip-cutter capable of being used for the operations of slicing, fingering, or pulping at pleasure.

In this class of cutting machines we have also to include some neatly-constructed sausage-chopping machines exhibited by Mr. John Gardner, of Birmingham. In these machines the materials to be cut up are placed in a revolving pan with a wooden bottom, and subjected to the action of five rising and falling knives (one of which is placed at right angles to the others), driven from a crank shaft, which extends across the top of the machine. One of the machines exhibited had an engine combined with it on the same frame.

Wood-Working Machinery.

Decidedly the largest collection of wood-working machinery at the Show was that of Messrs. Thomas Robinson and Sons, of Rochdale. The exhibits of this firm included some strong and well-made circular saw benches, their comprehensive "universal general joiner," of which we gave a description in our account of the Oxford Show, a band saw, of particularly neat design, which we intend to illustrate next week, a very good combined deal and log frame, which we shall also probably illustrate, and a variety of planing, moulding, mortising, and tenoning machines, and deal frames, &c., of the usual patterns made by the firm. Besides these, Messrs. Robinson's exhibits also included one of Armstrong's ingenious and now well-known dovetailing machines, which has already been described in our pages. The workmanship in the whole of Messrs. Robinson's machines was excellent.

Of the chief novelties at Messrs. Allen Ransome and Co.'s stand we gave an illustrated description in our last number, and we need merely add here, therefore, that the other exhibits included one of the handy little shaping and chamfering machines, and the quadruple spoke-shaping machine, respectively illustrated by us on pages 63 and 86 of our last volume.

Messrs. Charles Powis and Co.'s, of Millwall, exhibits were not all erected when we left Wolverhampton, and we can therefore say but little about them. So far as we could see, however, they were all of the regular patterns made by the firm with the exception of a new "carpenter and joiner," the details of which, however, we were unable to examine. Messrs. Charles Powis and Co. also exhibited an engine for driving their machinery, this engine being of a pattern somewhat resembling Messrs. Tangye's, but having the cylinder cast in one piece with the bedplate.

Messrs. Powis, James, Western, and Co. showed a large collection of machines, including several of very good patterns, but no special novelties. Amongst the exhibits at this stand we noticed a good set of machines for wheelwrights, including spoke-shaping and tanging, and felloe boring and shaping machines. The whole were driven by an engine having its cylinder inclined at an angle of about 45° to the base-plate, which also carried a vertical boiler. The general workmanship of this engine was good, but its appearance was much marred by the arrangement of the steam and exhaust pipes and by the want of lagging on the boiler and cylinder, while we doubt greatly whether the inclined position chosen for the engine proper possessed any advantage counterbalancing the extra cost of construction which it involves.

Miscellaneous.

At the stand of Messrs. Woods, Cocksedge, and Warner, of Stowmarket, we remarked a very simple little machine well worthy of notice in the class of which we are now speaking. This machine, which is the invention of the Rev. O. Reynolds, of Debach, is for making thatch, an operation which it accomplishes in a very simple way. The machine consists of a wooden frame supporting a spindle which is turned by a boy, this spindle having mounted on its inner overhanging end a wooden disc carrying a pair of bobbins, on which a supply of soft iron wire is wound. The two wires from these bobbins are led out through two holes in the disc, and across to the other side of the frame, where there are pairs of small rollers—the upper ones carried by a spring—between which the thatch, when made, is passed. Let us suppose the disc carrying the bobbins to be in such a position, that the holes through which the wires are led are situated one above the other in a vertical line. This being the case a bundle or wisp of straw is placed between the wires, and the disc is turned one revolution. This secures the wisp of straw by forming a twist in the wires close to it on the side next the disc, and this being done a second bundle is inserted between the wires, and secured in like manner. In this manner a mat of thatch, consisting of a number of bundles of straw connected by iron wires and secured by a twist between the bundles, can be turned out at a very rapid rate. The thatch thus made can be turned to useful account in many ways.

Messrs. Webb and Son, of Stowmarket, were the exhibitors of an excellent show of machine-driving bands, as were also Messrs. J. and T. Hepburn and Sons, of Southwork. Of Warren's street-sweeping machine, an exhibit well worth notice, we have given an account on page 50.

Mr Robert Willacy, of Preston, exhibited his patent appliances for preparing and supplying food to cattle. The idea of feeding cattle by machinery is somewhat extraordinary, but we do not doubt the expediency of the "cattle feeder" when made use of on a large scale. In cases where hundreds of heads of cattle have to be fed, such an apparatus as designed by Mr. Willacy would certainly be useful, economising labour and securing regularity in feeding. The implement is a kind of wagon provided with turnip cutter, oil cake mill, and chaff and pulp distributor, and while being propelled by means of a handle and suitable gearing, along a tramway in front of the cattle the machine delivers the food into the feeding trough of each animal. In this manner, 100 cattle can be fed by a man and lad in the brief space of 10 minutes; the cattle feeder making repeated runs until the beasts are fully fed.

The machines for washing and cleansing potatoes ex-

hibited by Messrs. Hancock and Co., of Birmingham, attracted some attention at the Wolverhampton Show, this being due, no doubt, in a certain measure, to the peculiarly convincing demonstrations of the gentlemen showing these machines in operation. The "waste not" potato machine, as manufactured by Messrs. Hancock and Co. in various sizes, is really a very useful apparatus of simple construction and doing its work with great ease and rapidity. The small household machines peel 5 lb. of new potatoes in 1 minute, or, 5 lb. of old potatoes in 2 minutes, and if the machine be worked but half the time required for peeling, it will simply cleanse the potatoes without removing the skin, preparing thus the potatoes for roasting or for cattle. The larger sized machines, capable of washing, cleansing, and peeling up to 20 lb. in a few minutes, are suitable for large farmers and other establishments. The principal apparatus consists merely of a tub containing water and the potatoes requiring peeling. By turning a handle and gearing (which, in the case of smaller machines can easily be done by a child), a series of hard revolving brushes are made to bear upon the potatoes until every particle of impurity has been removed.

Mr. George L. Scott, of Manchester, exhibited one of his admirable wheel-moulding machines, of which we have frequently had occasion to speak in favourable terms, and the use of which is, we are glad to hear, rapidly extending. The particular machine shown at Wolverhampton was capable of moulding wheels of all kinds from 20 in. to 12 ft. in diameter, and up to 18 in. wide on the face. As most of our readers are no doubt aware, Mr. Scott employs a pattern of a single tooth only, and forms the wheel by moulding the teeth successively from this pattern—a plan which insures perfect uniformity, and saves much expense in patterns. As a rule, also, Mr. Scott does not employ moulding boxes, the main centre column of the machine being planted in a suitable bedplate imbedded in the floor of the foundry, and the pattern being carried at the end of a radial arm projecting from this column, and moved round as each tooth is moulded by suitable dividing gear. The machine is very easily managed by any moulder; and while it saves much time, it turns out work with an accuracy which cannot be attained by ordinary hand labour. Another wheel-moulding machine was also exhibited at Wolverhampton by Messrs. Whittaker and Co., of Oldham. In this machine, the arrangement of which appears to us to be much inferior to Mr. Scott's, the model is formed in a moulding box, and this box is mounted on a kind of horizontal faceplate, which, after the formation of each tooth, is turned round the required distance by the dividing gear. But in making the large wheels the moulding box and its contents form a very heavy mass, and the task of moving this mass appears to us to be far harder work than it is desirable to put upon the dividing gear. Like Mr. Scott, Messrs. Whittaker mould one tooth at a time, but their pattern is carried by an arm projecting from a pillar situated outside the moulding box, and from the position of this pillar the arm must necessarily be longer, and therefore more liable to spring, than is required in one of Mr. Scott's machines moulding the same sized wheel. The pattern also used by Messrs. Whittaker has to be set by the aid of a trammel from the central spindle, and a source of error is thus introduced. In the case of moulding large wheels, also, the cost of moulding boxes required on Messrs. Whittaker's plan would be an important and objectionable item.

Messrs. William Weeks and Son, of Maidstone, exhibited the only hop-pressing machine shown in the grounds, this machine consisting of a pair of cylindrical casings for containing the "pockets" to be filled, each casing being provided with a piston capable of being forced down on the hops in the "pockets" by a rack and pinion. The casings open for the removal of the pockets when filled. There is nothing new about this arrangement, but Messrs. Weeks exhibited a new hop bine cutting machine, for cutting the bine into short lengths for manure, &c., and also some new hop "shims" and "nidgets." At present it appears to us that almost all the mechanical appliances for drying and packing hops are of a very crude kind, but we trust that now that the Royal Agricultural Society are taking an interest in the matter, some really valuable improvements may be effected.

Mr. Richard Bewley, junior, of Uttoxeter, exhibited a well-made and simple machine for grinding gold, colour, &c. In this machine the materials to be ground are placed on a horizontal slowly revolving slab, and subjected to the action of seven glass mullers, carried by a frame, which extends across the slab, and the ends of which are respectively attached to a pair of cranks fixed at the top of a couple of vertical spindles revolving at a much higher speed than the slab, being, in fact, driven by pinions on them gearing with teeth around the periphery of the latter. The circular motion of the mullers, combined with the slow revolving motion of the slab, causes the material placed in the latter to be very thoroughly acted upon.

Messrs. Henry Pooley and Son, of Liverpool, in addition to a large collection of their well-known weighing machines of various patterns, exhibited an improved form of their automatic grain scale. This scale, in the form in which it was exhibited by Messrs. Pooley, at Oxford last year, was illustrated by us on page 258 of our last volume; and the machine shown by them at Wolverhampton is similar in principle, but has been modified in construction, so that it can be used with ordinary standard instead of special weights. This is a most important improvement, as it enables one machine to be used for weighing grain according to the standards of any country, and without requiring the employment of any weights other than those in ordinary use in that country. The machine has a continuous feed, and that exhibited at Wolverhampton was capable of weighing and registering grain automatically at the rate of 12,000 lb., or any less quantity per hour. The details of this grain weigher are of a very simple kind, and are all perfectly accessible, and altogether the machine is one calculated to be of such great service in granaries, breweries, &c. that we expect to see it come very largely into use. We may mention that in April last this grain weigher was subjected to a public test at Messrs. Pooley's show-rooms at Liverpool, and its accurate performance on that occasion has been certified by a number of Liverpool merchants of high standing.

Messrs. David Hart and Co., of the North London Iron Works, London, show a number of Stanley's patent weighing machines without loose weights. These machines are made either portable or fixed. In the former case, the machine can be furnished with back railing for light goods; or with cradles to take bar iron; or, finally, with a pen to take in live cattle; machines of this class are made to weigh goods up to 25 cwt. In the case of the fixed machines, which are constructed to weigh up to 5 tons, the pillar is made reversible, so that it can be arranged either way, i.e. parallel to the platform, or at right angles to it. The principal advantage possessed by these machines is that they have no loose weights whatever. The goods are weighed by means of two sliding weights arranged, side by side, on the steelyards, one representing cwts., the other the intermediate lbs., or any other standard weights. When these two weights are both at zero they simply balance the weight of the platform and other working parts of the apparatus. It will be seen that this arrangement, by doing away with any calculation of loose weights, prevents mistakes; moreover, as the weights are never taken off the steelyard, they cannot be lost or mixed with other weights, or become clogged with dirt.

Messrs. Siddeley and Co., of Liverpool, exhibited in action several of their ice-making machines; but during the earlier days of the Show the weather was scarcely of such a character as to cause their performance to be appreciated. We noticed that since the Oxford Show Messrs. Siddeley have altered the arrangement of the valve boxes of their pumps, so as to render the valves more readily accessible. Amongst other places one of Messrs. Siddeley's machines is now in use at Messrs. Reid's brewery, cooling 30 barrels per hour from 55° to 33°, the power used being 25 indicated horse power.

At the stand of Messrs. Tangye, Brothers, and Holman, we noticed, besides the exhibits of which we have already spoken, a very good form of snatch-block designed by Mr. George Tangye. In this block one side of the frame has the axis of the sheave fixed in it, while the other side is formed so that when in place it takes hold of the projecting end of this axis and supports it. This last mentioned side is rigidly attached to the hook by which the block is suspended, the effect being that when the strain comes upon the block the loose side is forced into its proper position for supporting the axis of the sheave.

Messrs. Head, Wrightson, and Co., of Stockton-on-Tees, exhibited a number of Mr. Thomas Moore's ingenious pulley blocks. According to Mr. Moore's plans the load is suspended by a double chain, each part of which passes over a chain pulley. The two pulleys are driven in opposite directions by epicycloidal gear, the peculiarity of the arrangement being that each pulley acts as the abutment for the other, and the two parts of the double chain are thus submitted to precisely equal strain. The epicycloidal wheel which imparts motion to the chain pulleys is carried by an eccentric on an axis provided with a chain wheel, over which a hand chain passes. The arrangement is one well adapted for its purpose, and the blocks appear to be very well made.

Messrs. B. and S. Massey, of Manchester, were, as usual, exhibitors of their handy steam hammers; but we noticed no novelties at their stand. Close by Mr. Isaac Gray Bass, of Sheffield, was the exhibitor of a variety of machines, including one of Messrs. Waldenström and Bass's bolt-making machines, which seems likely to turn out good work, and one of Mr. W. Bass's nail-forging machines, in which the nails are made hot, and are rolled to shape, cut off, and headed at one operation.

Mr. James Sinclair, of Manchester, showed a chemical fire engine of the class illustrated and described by us on page 240 of our eighth volume, and also a number of "Pextincteurs" and specimens of Galibert's respirator for enabling firemen or other persons to enter places filled with smoke or gases unfit to support life. This is really a very useful contrivance, and deserves to be generally known. In mines it might frequently do good service, as the portable air reservoir with which it is fitted contains a sufficient supply of air to last some three-quarters of an hour or so, and the person wearing the respirator would thus be able to traverse considerable distances. At an adjoining stand Mr. Robert Morton, of Stockton-on-Tees, showed some of his brass boiler mountings, which were well worthy of notice, from their neat and substantial design and good workmanship.

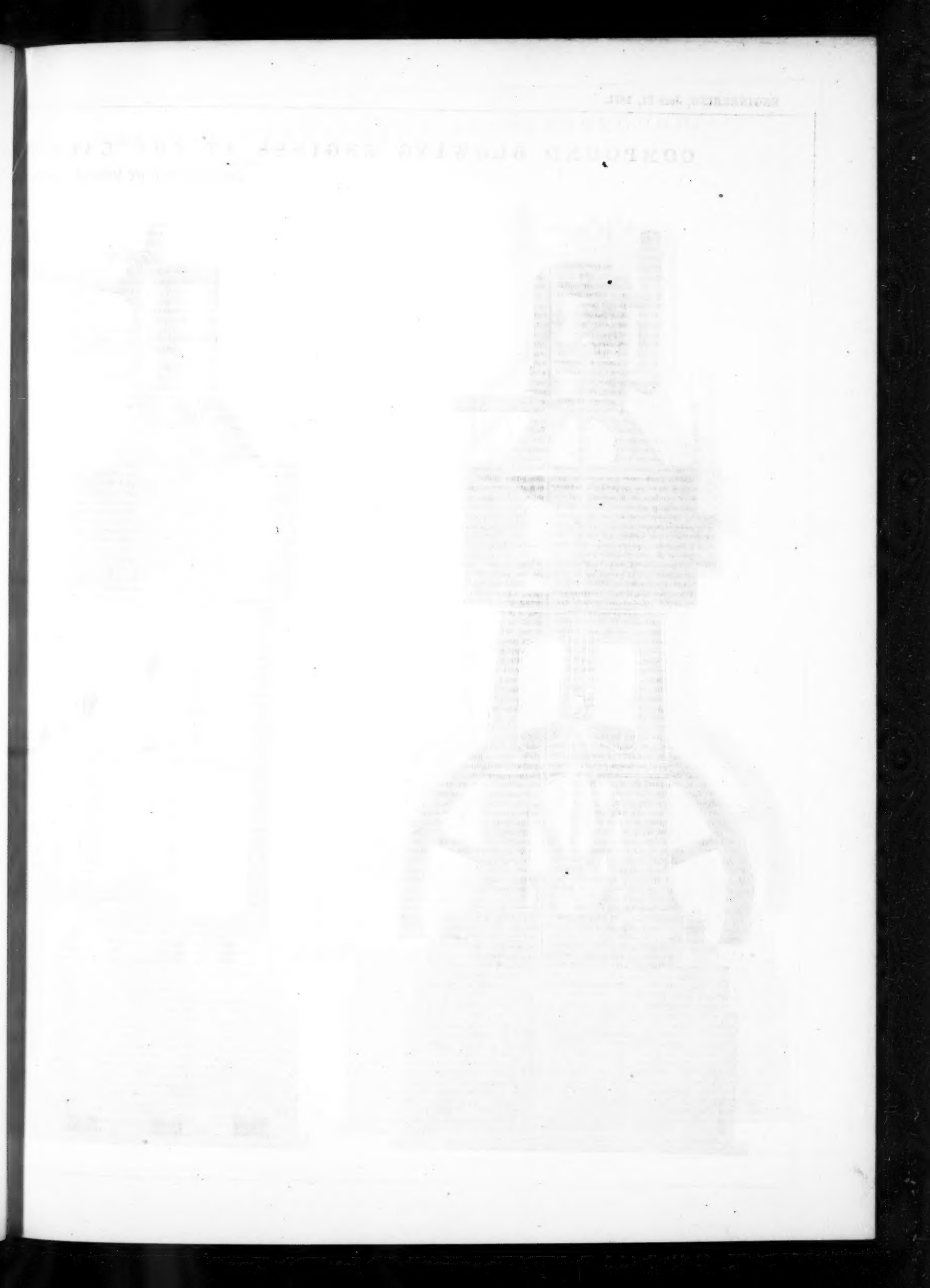
Corn-drying apparatus was shown by two exhibitors, namely, Messrs. Davey, Paxman, and Co., of Colchester, and Milburn and Co., Limited, of London. Messrs. Davey, Paxman, and Co.'s apparatus was of the pattern which they have now made for some time past, and which has been very successfully introduced in a large number of cases. In this apparatus the corn is dried by passing it over steam-heated surfaces, and subjecting it, at the same time, to the action of a current of air which has been warmed by passing over other surfaces also steam heated. The action is very efficient, and the cost is stated to be but 3d. per sack. Messrs. Milburn and Co. exhibited one of their steam-heated drying machines for drying corn, brewers' and distillers' grains, &c., and also a combined portable engine and drying machine. The former apparatus, which is specially adapted for desiccating brewers' grains, consists of two boiler-plate shells fixed concentrically, and forming a jacket which is filled with steam. Within the inner cylinder revolving shelves or trays are mounted upon an axis which is driven by suitable gearing at a speed of about two revolutions per minute. A hopper, with self-acting screw for feeding the grains or corn into the machine, is mounted on the top, and at one end of the drier, while, at the other end, exit for the dried grains is provided for. We understand that these machines have proved a success, as the desiccated grains are considered very good food for all sorts of stock, and fetch readily from 6*l.* to 7*l.* 10*s.* per ton, according to locality and the price of other feeding materials. With 30 to 40 lb. of steam pressure such a machine is drying at the rate of about 8 bushels per hour, while the power required to drive it is but ½-horse, and the steam necessary to supply the jacket equivalent to about 3-horse power. The second, or combined portable and drying machine, exhibited by Messrs. Milburn and Co., is specially intended for farmers' use, as it will drive a thrashing machine or any other implement whilst being employed as a drying apparatus.

Messrs. Schäffer and Budenberg, of Manchester, had on exhibition a large assortment of their well-known vacuum, hydraulic, and mercurial gauges, manufactured at their works at Buchau, near Magdeburg. They also exhibit one of Ehrhard's hand fire engines and pumps. This is a double-action pump, with valves so arranged in a cylinder that they can be easily removed and cleaned by unscrewing the cylinder cover; the whole makes a compact and, we should think, a very effective apparatus. Messrs. Schäffer and Budenberg also show a very peculiar and sensitive form of rotating governor, invented by M. Buss, of Berne. M. Buss has devoted considerable time and labour to the perfection of this new governor, which we could not properly describe without drawings. The latter have, however, been promised to us, and we shall, when we publish them, explain the theory of this ingenious contrivance.

Messrs. James and Son, of Cheltenham, showed, in addition to some of their well-known bone crushers, a cheaply-constructed chain pump, suitable for irrigating purposes, and also for use in brickfields or other similar situations. One of Messrs. James's pumps, fitted with a barrel of 3½ in. diameter by 10 ft. long, and worked by two men, can raise about 3000 gallons per hour. With the smaller pumps, having a 2 in. barrel, one man can easily raise about 600 gallons per hour. Mr. Alfred Peirce, of London, had some useful small articles on view, among others an improved telescope lengthenable ladder, also a combined tubular iron step ladder, which is so jointed that it can readily be used as a step. In this latter case, however, we doubt whether the implement would be possessed of the necessary lateral stability. Amongst other minor exhibits, also, we must notice a neat little gas-heated boiler, which was shown by Messrs. Amies and Barford. This boiler consists of a series of flat compartments made of copper, which jut out one above the other from the opposite sides of a chamber, at the bottom of which the Bunsen burners are placed. The arrangement is such that the hot gases pass from side to side between the successive compartments, and finally escape at the top of the casing; all the compartments communicate with one common chamber, and the amount of exposed surface is such that the heat generated by the combustion of the gas is very efficiently utilised.

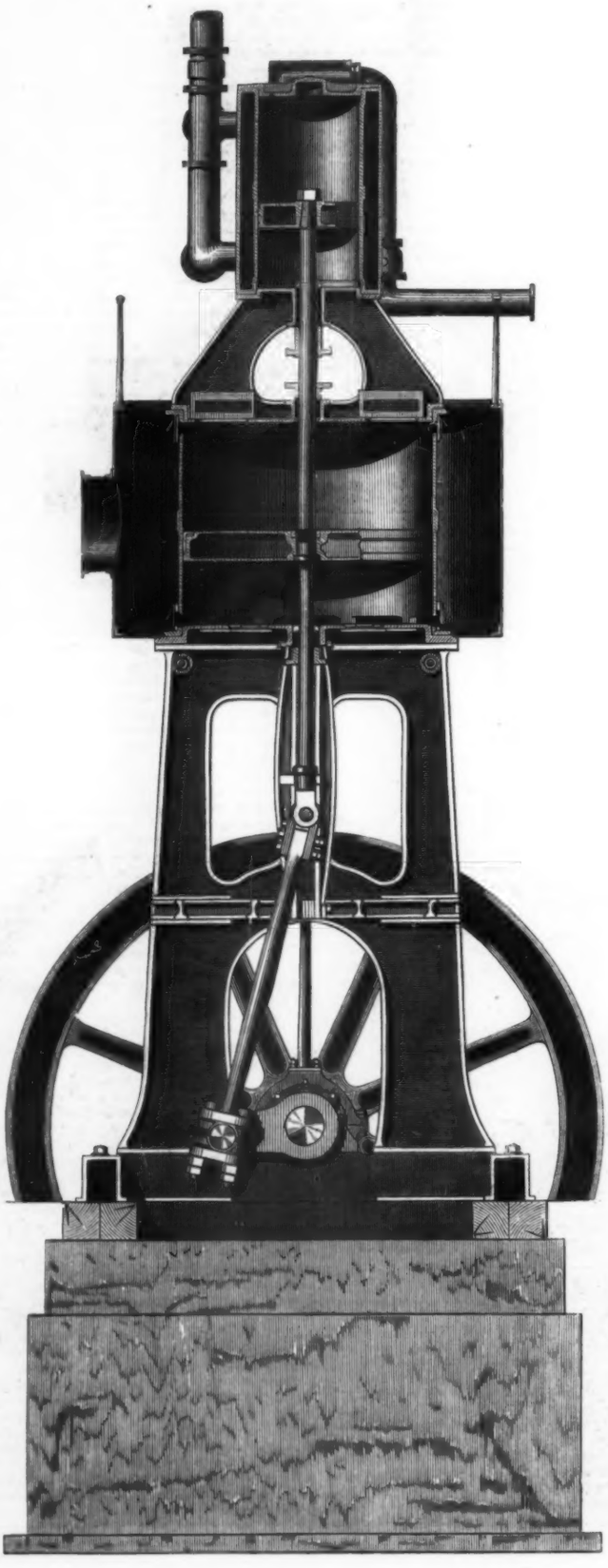
Manufacturers of iron fencing, gates, and similar matters, made a great display at the Wolverhampton Show, and in this class Messrs. Francis Morton and Co., of Liverpool, had a particularly fine collection of exhibits. Amongst a variety of other things at their stand we saw specimens of a new pattern of continuous self-wedging bar iron fencing, of very simple construction, and very easy to erect, while there were some exceedingly neat patterns of wire fencing, and a large collection of iron buildings of various kinds—from a church to a barn—which had been constructed by the exhibitors. Mr. George Fletcher, of Wolverhampton, likewise had a very good collection of iron gates and fencing, as had also Messrs. Bayliss, Jones, and Bayliss, of Monmore Green, Messrs. Hill and Smith, of Brierly Hill, and Messrs. Hydes and Wigfull, of Sheffield. Manufacturers of stable fittings also were exceedingly well represented, the St. Pancras Iron Works Company, London, especially having a very good display of the various fittings and stable and harness-room accessories manufactured by them.

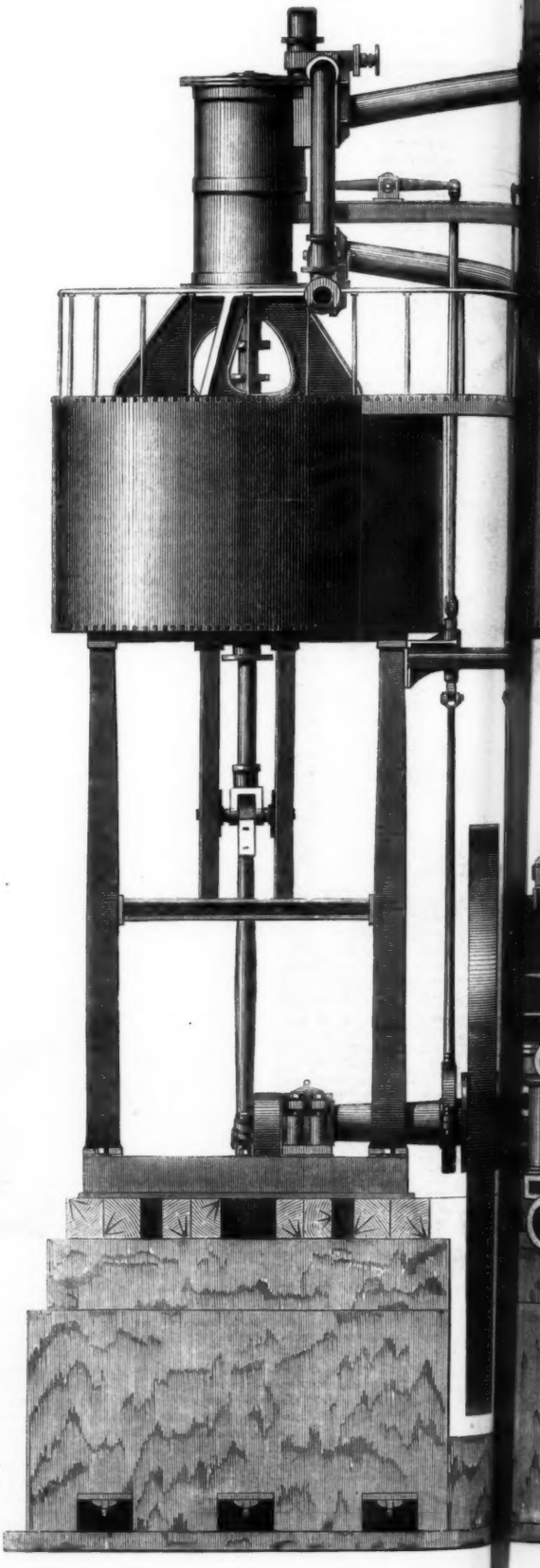
We have now completed our general survey of the Wolverhampton Show, and although our account is necessarily not an exhaustive one, yet we trust that we have been able to direct the attention of our readers to the leading novelties which the showyard contained.



COMPOUND BLOWING ENGINES AT THE LACKEN

CONSTRUCTED BY MESSRS. KITSON

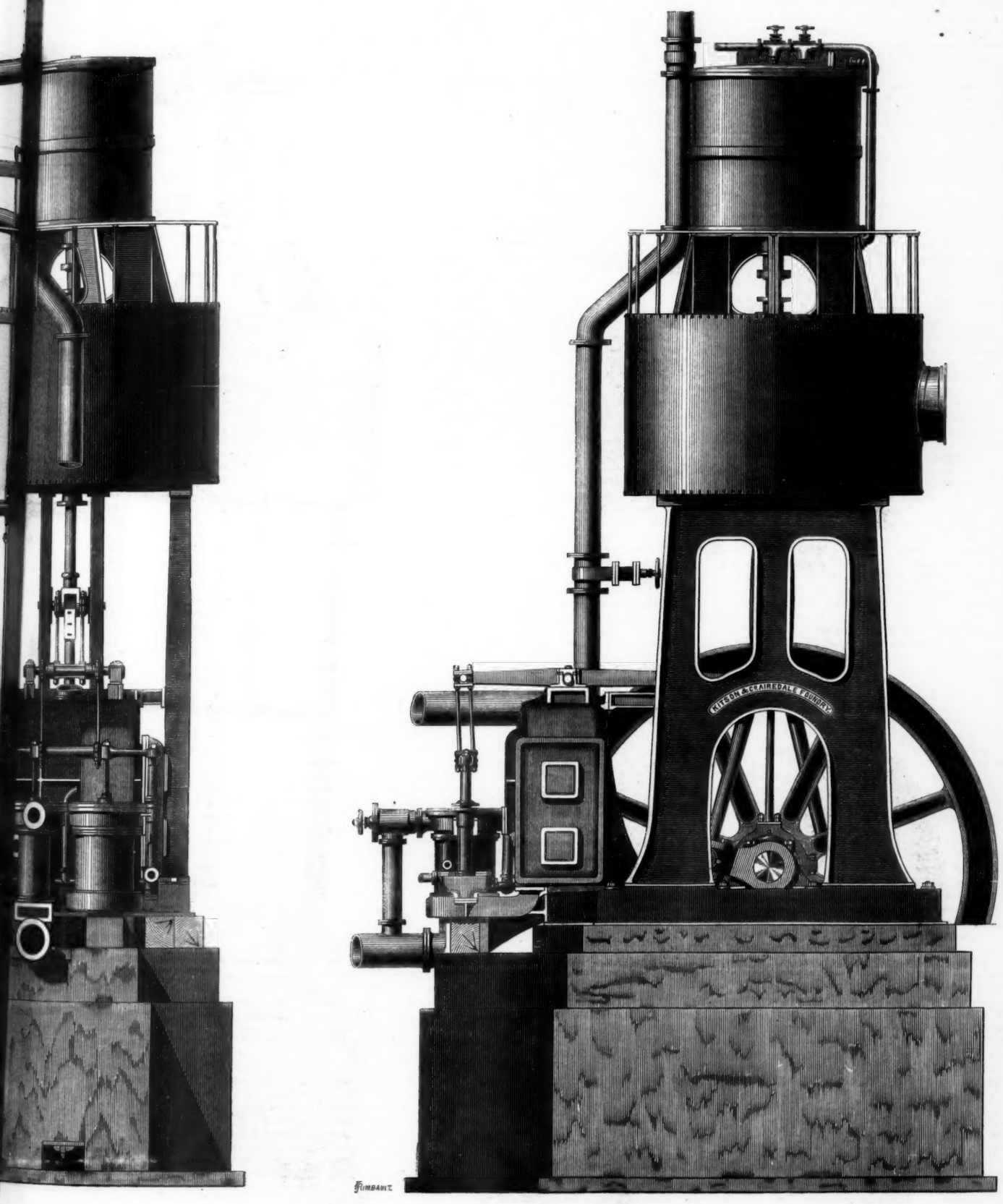




EN RON COMPANY'S WORKS, NEAR MIDDLESBROUGH.

SON GINEERS, AIREDALE FOUNDRY, LEEDS.

(Fo 47.)



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CONTENTS.

	PAGE		PAGE
The Mont Cenis Tunnel	37	Tredgold's Elementary Principles of Carpentry	48
Submarine Blasting	39	Titanium and Iron	48
The Royal Agricultural Society's Show	39	Narrow Gauge Railways	48
Tramways	43	Notes from the South-West	49
Experiments at Shoeburyness	45	Notes from the North	49
Newcastle College of Physical Science	46	Notes from Cleveland and the Northern Counties	49
Compound Blowing Engines	47	Foreign and Colonial Notes	49
Narrow Gauge Railways	47	Warren's Street Sweeping Machine	50
Stone Caissons	47		

ENGINEERING.

FRIDAY, JULY 21, 1871.

TRAMWAYS.

ALL those desirous of investing capital in tramways need not be disappointed at any check these lines of communication have received, or may receive in the metropolis. The world is open to them, and on all sides the opportunity offers itself for this class of investment. There is the Dublin Tramways Company, with its capital of 240,000*l.*, the Lisbon Steam Tramways Company, with 200,000*l.* capital, the General Tramways Company, with a million pounds capital, and others. The latter is a most comprehensive scheme, formed for the purchase of Acts and concessions for tramways in the United Kingdom, and on the Continent, and for their construction and maintenance. Already it has secured certain tramways, and has concluded contracts for others in Spain, Portugal, and Italy, from which large revenues are anticipated when they are in operation. Lisbon is in a fair way to be well provided, if ever the announced views are carried out. What with the 86 miles of steam tramways one company is going to make it a special business to build, and another system, for which the comprehensive association alluded to has concluded the contracts, Lisbon and its suburbs will have enough street railroads. The two companies, it will be observed, have very different notions as to the cost of their respective lines, the one undertaking the construction of 86 miles—including stock and locomotives—these tramways are to be steam worked—for 4500*l.* a mile, while the estimates of the other company for a horse tramroad are 8500*l.* a mile; in the former scheme a speed of 12 or 15 miles an hour is promised, in the latter the more sober rate which prevails in the metropolis would not be exceeded. There can be little doubt as to which will prove the more profitable system of the two; a steam worked line, capable of comparatively high speeds, and costing only a little more than half the price of a horse worked road, has much to recommend it besides its reduced capital account. We have always considered that mechanical power ought to supersede animal power on these lines whenever it is practicable, and the one great objection alleged against its use—that of the interference with the other traffic—will be well tested if these Lisbon lines are completed. The motive power selected is, we cannot help thinking, however, open to grave objections which may not be developed when the road is in first-class working order, but which, we fear, will be discovered after a lengthened trial. The system to be adopted is that known as Larmanjat's, in which a central rail only is employed, which is gripped by a pair of double-flanged wheels placed in the longitudinal axis of the engine, while a pair of broad-flanged driving wheels, actuated by gearing, bear upon the ordinary road surface. The carriages are provided each with a central wheel and four side wheels, the principal part of the weight being carried upon the central wheel, the side wheels steadying the vehicle. The great merit on this arrangement, which is a kind of compromise between a traction engine and a locomotive, lies in the cheapness of the permanent way required, the cost of which, as already published, being only 450*l.* or 500*l.* a mile. But we think it doubtful whether this economy in first cost will prove economy in the long run. It is possible, indeed, that this estimate has been understated, otherwise we are at a loss to account for the remaining 4000*l.* per mile which the line is to cost.

We fear, however, that these cheap lines will be attended with heavy expenses in maintenance, for it would be, above all things, necessary, for the proper working of such an arrangement as Larmanjat's, that the roads should be kept in perfect order, and the wear caused by the wheels of the engine and train would, we apprehend, be found excessive, while the shocks caused by an irregular road surface, to say nothing of the inconveniences to the passenger, would be highly destructive to the engine when run at a comparatively high speed. This scheme, however, of applying steam power to street railroads is one that will probably be attended by highly important results; it is the first step towards what we believe will be the ultimate practice in one shape or another upon street railroads. But we think that this company would have made a wiser choice had they decided upon adoping a surface line with suitable engines and rolling stock, the locomotives being provided, if necessary, with proper appliances for surmounting steep gradients. The advantages and disadvantages of the Larmanjat system can, however, be decided only by experience, and we by no means wish to pass any unfavourable opinion, being only too glad to see a chance of the question of steam-worked tramways being worked out.

Upon the more costly scheme proposed by the General Tramways Company we can look with little favour. The same objections are to be made to it as apply to many horse railroads elsewhere; for the same expense per mile which it is proposed to incur, an asphalte roadway could be laid down, giving equal advantages to all vehicles, whilst for little more than half the money, a light steam-worked line could be constructed, of far greater carrying capacity than any horse railroad. It is surely an obvious conclusion that a railway cheaper to make, cheaper to stock and to work, and of far larger capacity, would be preferable to a horse-worked road. This conclusion, however, is one that is far from being acknowledged, and it will only be through a long and costly experience that we shall ultimately arrive at the adoption of the most economical and efficient system of working street railways.

EXPERIMENTS AT SHOEBURYNESS.

THE gunnery experiments recently carried out at Shoeburyness, the results of which were briefly summarised by us last week, were of considerable importance, and of equal practical value. They developed in the first place the penetrative power of the 11-in. gun, which sent its projectile through 13 in. of armour plating and 12 in. of teak backing, besides 1½ in. of iron skin. In the next place they determined the relative values of the much-lauded Prussian field gun and our own guns of the same class, the superiority of the latter being incontestably and fairly established. The first part of the experiments consisted of practice with the 9-in. and 11-in. guns, which were laid against a target recently designed by the War Office. The target is 48 ft. in length by 9 ft. in height, and represents two distinct systems of construction. In the one the face consists of an 8 in. armour plate, manufactured by Messrs. Cammell and Co., 6 in. of teak, and behind this a 5-in. armour plate, by Messrs. John Brown and Co., backed by 6 in. more teak with skin-plating 1½ in. thick in the rear. The remaining portion of the target is built up upon the principle of the recent test targets, and has an 8 in. face plate, backed by 18 in. of teak, supported by a ⅜ in. iron skin, and stayed with iron ribs representing the framing of an ordinary ironclad ship. The plates are all arranged so as to break joint with each other, the front plates in the compound portion of the target being 22 ft. 6 in. and 25 ft. 6 in. long respectively, the rear plates averaging 15 ft. in length. The firing was all made at 200 yards range, the 9-in Woolwich muzzle-loading rifled 250-pounder gun being laid against the 8-in. or single portion, and the 11-in. Woolwich muzzle-loading rifled 500-pounder gun against the 13 in. or compound portion of the target. The calibre of the latter gun—11 in.—is a novelty at Shoeburyness, although the gun itself is of the same weight as the old 12-in. 600-pounder.

The 9 in. gun had the first innings, charged with 43 lb. of R.L.G. powder, a 9 in. small coned Palliser 250 lb. shot, with 1.5 ogival head, empty, and plugged in the rear, and laid against the 8 in. or A portion of the target. The shot struck the upper plate 6 ft. from its proper right end, and 12 in. from its lower edge, making an indent of 10¼ in. mean diameter. The head of the shot remained in the hole, and gave a total penetration of 13½ in., the rear portion of the target remaining intact. In the second round, from the same gun, with a large cored Palliser empty shot, the projectile struck the same plate 9 ft. 6 in. from the proper left end, and 1 ft. 2 in. from the lower edge. An indent, 9.3 in. in diameter, was made, the head of the shot remaining in the hole, giving a total penetration of 2 ft. An examination of the rear of the target disclosed two broken ribs and a bulge, with some slight cracks in the skin. The third round consisted of the same powder charge, and a Palliser shell carrying a 5 lb. 8 oz. bursting charge, which struck the lower plate 7 ft. 9 in. from the proper right end, and 2 ft. from the base of the target. A hole was cut clean through, the diameter at the front being 9½ in., whilst in the rear the skin was broken away over an area of 18 in. by 15 in., one rib and angle iron being forced out and distorted. The fourth and last round with this gun was fired with the same powder charge as before, and a 9 in. large cored shot having a 4 lb. bursting charge. It struck the target at the junction of the upper and lower plates, knocking a hole clean through to the rear, the skin being broken away, and one of the ribs being bent back for a length of nearly 3 ft.

The 11-inch gun was next laid against the B, or compound portion of the target, the first round being fired with 85 lb. of pebble powder and a large cored empty Palliser shot with shell plug in rear. The upper plate of the target was struck 8 ft. 6 in. from the proper right and 1 ft. 3 in. from the lower edge, complete penetration being effected. The mean diameter of the hole was 11¼ in., and the plate was lifted bodily up and separated from the lower one, the separation between the plates being 1.2 in. at the proper right end, vanishing to *nil* at the other end. The damage to the rear was considerable, one rib being torn away for the entire height of the target and buckled 15 in. in the centre. The hole in the rear was 12 in. diameter, and the outer skin was torn away over an area of 20 in. by 20 in., a 3 in. armour bolt being considerably bent. The head of the shot was found about 80 ft. to the right of the target, having taken a course nearly at right angles with the line of fire, and grazing first at about 42 ft. The second round was fired with a similar charge to the last, the shot having a 6 lb. bursting charge. The projectile struck the upper plate 16 ft. 6 in. from the proper left end and 2 ft. from the lower edge. Like its immediate predecessor it passed clean through the target leaving a hole in front 11.2 in. mean diameter and buckling the plate 1 in. over its whole length, the rear one rib was broken through and another much damaged, whilst a third was torn away from the skin, twisted, and buckled 6 in. in the centre. A number of rivet heads were cleared off and an opening was made in the backing 12 in. across, the skin being torn away over an area of about 2 square feet.

In a previous series of experiments at Shoeburyness, made against the 14 in. solid-plated and the 8 in. with the 6 in. compound turret targets, with the 11 in. gun, that weapon failed in complete penetration. Now, however, it has gained the mastery with a reduction of only 1 in. of metal and

6 in. of timber. This victory appears to be due to the reduction of 1 in. in the calibre of the gun, which seems to give the requisite penetrative power, although the weight of the projectile is decreased. There is, of course, less work to be done by the shot in the present case in the way of displacement of metal, as the hole to be punched is 1 in. less in diameter than with the 12 in. 600-pounder shot. The character of the metal in the plates may be judged of by the fact that the shot holes were as clean as they possibly could be, no cracks or fissures appearing, whilst the holes were but the veriest trifle larger than the projectiles which had made them. So with the shot; they were of splendid quality, and for this credit is due to Colonel Milward, C.B., R.A., who has successfully solved the problem of the proper admixture of irons required in the production of a perfect chilled projectile. The results of these experiments have some bearing on the proposed enlargement of the calibre of the 35-ton gun from 11.6 in., as at present, to 12 in. Although they do not go to prove the desirability of such a step, it may yet be questioned, on the other hand, whether the retention of the present calibre will be of any use in rendering the gun serviceable. It should be borne in mind that the powder charge of 120 lb. occupies a great length in the bore of the gun, and that a portion of every charge is blown out unconsumed —as, indeed, it is in some of the heavier guns at Shoeburyness. By enlarging the bore of the gun the length of the powder charge becomes reduced, and, further, by igniting it in a central manner, as long since proposed by Sir Joseph Whitworth, its full theoretical power may probably be developed, especially if powder pellets of slightly smaller diameter than those hitherto used be tried. However this may be, the guns are certainly victors over the targets once more.

We now come to the second part of the experiments, which had for their object the trial of the Prussian 4-pounder rifled breechloading field gun. This weapon is equivalent to our rifled 9-pounder, as it fires a 9.5 lb. cylindrical common shell with a simple percussion fuse. The reason of its being called a 4-pounder is that on the Continent the practice is to denominate a piece of ordnance according to the weight of the round shot it will carry. The shells used with this gun are lead-coated, and break up well on bursting; 48 of these projectiles are carried in the limber. The breech action consists of a double wedge sliding in from the side. The gun, which is made of steel, is 6 ft. long, and weighs 5.41 cwt., and burns a powder charge of 1 lb. 10 oz. The competition lay between this gun and the English new muzzle-loading 9-pounder and 16-pounder guns. The first practice was 3 minutes firing from the Prussian gun and the English 9-pounder gun for rapidity. The Prussian gun got off eight rounds, the ninth being in the gun, whilst the English 9-pounder fired 11 rounds in the same time. In the next place 25 rounds were fired from each gun at 1000 yards range to test rapidity and accuracy combined. The 16-pounder fired its allotted number of rounds in 12 minutes 48 seconds, making 14 hits at the 1000 yards range. The 9-pounder gun got rid of its 25 rounds in 8 minutes 37 seconds, scoring 13 hits, whilst the Prussian gun occupied 10 minutes 15 seconds in doing the same thing. The Prussian gun thus took nearly 20 per cent. more time to do the same amount of work and with the same results as the English 9-pounder. As every care was taken that the guns should be served with equally efficient hands, this result seems to dispose of the argument that breechloading field guns can be fired with greater rapidity than muzzle-loading weapons.

The remainder of the trials had reference to the effects of these guns against troops, and they were accordingly trained against targets representing four columns of troops at 800 yards range. The general results were thoroughly in favour of the English guns, although it was really not so much a question of guns as of projectiles. The English weapon, firing shrapnel shell and percussion fuses, showed immense superiority over the Prussian gun with common shell and percussion fuses. Although the latter weapon was greatly in the minority as regards hits, there is little doubt that it would have scored a much smaller number but for the circumstance that the shells were coated with lead, which allowed of thinner metal being used for their walls. It is true that the English 9-pounder weighs 2 cwt. more than the Prussian gun, but then it must be borne in mind that our gun can be used as a 12-pounder if desired—a circumstance which fully compensates for the extra weight of metal in it. The velocity of the English gun is 200 ft. per second in excess of that of the Prussian, whilst at the same time the trajectory of the former gun is lower than that of the latter. Moreover, the cost of the English gun is less than that of the Prussian piece by about one-third. So that on all points the English gun appears to have the advantage. Inasmuch, however, as there has been a loud outcry about the superior merits of the Prussian gun, it was as well to demonstrate its capabilities clearly, and to definitively determine its value. This has been done, and we have no reason to change our well-known and tried Fraser steel-lined coil gun for the solid steel weapon of our Prussian friends. Neither our knowledge of the latter metal nor the results of the recent experiments justify any such step.

NEWCASTLE COLLEGE OF PHYSICAL SCIENCE.

WHATEVER other important centres of industrial enterprise may ultimately accomplish in the way of furthering the cause of technical education, or training in those scientific principles which lie at the foundation of all industrial progress, the town of Newcastle-on-Tyne has resolved that it will not lag behind. Many other towns and districts throughout the kingdom have talked and passed resolutions on the subject, but Newcastle has really taken action in a most decided manner, and that action will doubtless soon bring forth an abundance of good fruit. It is only about three months since that a meeting of some of the leaders of opinion in the north of England was held in Newcastle, when it was resolved to establish a College of Physical Science, an institution in which systematic courses of instruction should be imparted in such sciences as have an intimate relationship to engineering, mining, agriculture, and the industrial arts generally, or, at all events, such of them as are largely practised in the northern counties. The leading men of Tyneside were greatly stimulated by the very liberal offers and overtures made by the authorities of the University of Durham, who were represented at the meeting by the Warden of the University, the Very Rev. the Dean of Durham. It was determined at the same meeting to raise by subscription a capital sum of at least 30,000*l.* for the purpose of endowing the college; and besides giving a subscription of 300*l.*, the university authorities guaranteed a permanent annual contribution of 1000*l.* towards the establishment of professorships, and of ten scholarships of 20*l.* each to assist students, in the event of the subscriptions amounting to 30,000*l.* We understand that the sum already collected amounts to 24,000*l.*, and it is confidently anticipated that the sum will mount up to between 30,000*l.* and 40,000*l.* within the next few months. This is certainly evidence of progress of the right sort.

The "canny" people of Tyneside have resolved on avoiding the foolish practice of spending their pecuniary means on the erection of expensive buildings in which to house their Physical Science College. In the meantime they will content themselves with the accommodation which has been freely placed at the disposal of the Executive Committee of the College by the various scientific societies of Newcastle, and which, it is believed, will prove to be quite ample for the college for several years, and until it is fully established among the institutions of the north. In order to make a commencement in the ensuing winter session, advertisements were promptly issued for applications for four Professorships, which it was deemed would be absolutely necessary, these being Pure and Applied Mathematics, Chemistry, Experimental Physics, and Geology. Considering that the salaries alone were fixed at 400*l.* in one instance, and at 300*l.* in each of the others, it was natural to expect that amongst the applicants there would be men of mark; and the sequel has shown that such was the case. The elections were made two or three weeks ago, and in each case the appointment reflects much credit on the Executive Committee who made the choice. For the Professorship of Mathematics Mr. W. S. Aldis, of Trinity College, Cambridge, the Senior Wrangler in 1861, has been chosen; Mr. A. F. Marreco, M.A., for twelve years Reader in Chemistry in the University of Durham, and a gentleman who is thoroughly familiar with the chemical industries of the North of England, will fill the Chair of Chemistry; while the other two chairs—Experimental Physics and Geology—will be filled by Mr. A. S. Herschel and Dr. David Page, F.R.S.E., respectively; and with this staff the College of Physicial Science will assume an actual existence in the first week of October next.

That it has a future of public usefulness before it we have no manner of doubt. Having put to their hands, the hard-headed and clear-sighted Tyneside men will not willingly let this institution languish for want of support, either in the shape of funds or of students. The field in which, doubtless, it is to exercise a large measure of influence is very extensive, and so, likewise, is the variety of its industries; and hence it is just the proper district in which to locate a college of physical science. We hope to learn, however, that as the institution progresses its professorships will at least be increased by the establishment of a Chair of Engineering. University College, London; Owens College, Manchester; and the Universities of Glasgow and Edinburgh are all provided with such a Chair; and it would never do for a town whose history is so closely bound up with associations of the Stephensons, father and son, to consider itself fully equipped in an educational point of view until it had established a professorship in that branch of science in which those eminent men attained such great distinction. Doubtless such a Chair will be established in due time.

This Physical Science College promises to be one of the most useful public educational institutions of which we have any acquaintance in this country. As respects its constitution it is liberal in the extreme, and well entitled to be taken as an example by other towns which are moving or proposing to move in the same direction. Its connexion with the University of Durham brings no fetters, either political or theological. The four northern counties of Northumberland, Durham, Cumberland and, Westmoreland, and the North Riding of Yorkshire, will all have a direct influence in the government of the college; and so also will the Municipal Councils of twelve of the most important towns in those counties; and thus the interest felt in the existence and prosperity of the institution will be very widespread. But the government is not to be limited to the subscribers, the representatives of the Municipal Councils, and the territorial magnates; the learned societies of Newcastle, and more especially the North of England Institute of Mining and Mechanical Engineers, are to have a direct voice in it also. In every sense the constitution is most liberal. Of course, the University of Durham is entitled to an important share in the management of the college in virtue of its generous contributions towards its endowment. However, the authorities of that learned institution have contented themselves with having only one-third of the governing body named by themselves, thus showing an amount of self-denial that redounds greatly to their credit.

In the meantime, arrangements will be made for having day classes only; but should these not bring out a sufficiently large number of students, the experiment of evening classes will doubtless be tried. We feel satisfied that both the promoters and professors of the Physical Science College thoroughly understand the wants of the times, and the mission which the college is intended to pursue. The necessity for sound and thoroughly practical scientific instruction is much felt throughout the north, as well as in other industrial districts; and it is to be hoped that numerous scholarships and exhibitions may be instituted by the large employers of skilled labour, so that they may be certain of securing as servants persons well trained in scientific habits, and thereby able to apply with the utmost readiness the deductions of science in the various industries in which they may be engaged. Much of the future success of the college depends upon the encouragement given by the employers of labour for providing facilities for practical study; much also depends upon the professors, but they have already, each and all, proved themselves quite capable of taking in hand the duties to which they are now appointed; and, lastly, much depends upon the governing body, but when it is remembered that the learned leisure of the Dean of Durham, and the scientific knowledge and practical sagacity of Mr. Isaac Lowthian Bell are available, we need scarcely entertain the faintest fear of great success being ultimately attained.

NARROW GAUGE RAILWAYS.

ON another page we publish a letter from Mr. H. U. McKie, one of the gentlemen connected with the Festiniog Railway, and written in behalf of Mr. Spooner, the locomotive superintendent of that line. Mr. McKie—or shall we say Mr. Spooner?—appears aggrieved because, on a recent occasion, we took pains to point out the exact part that Mr. R. F. Fairlie has had in the introduction and development of narrow gauge railways, and in much detail we are taken to task for the statements we made in the article referred to. According to the writer of the letter we should have substituted Mr. Spooner's name for that of Mr. Fairlie, and have accorded to the former gentleman the credit of bringing about the present narrow gauge railway reform.

Mr. McKie, in his energetic letter, piles up so many questions upon each other that we fear we have not space to answer them, and, indeed, very few of them require reply. We are asked: "Is it not the fact that Mr. Fairlie knew nothing of the true merits of the working of narrow gauge railways until he saw the Festiniog Railway two years ago?" We cannot answer for the extent of Mr. Fairlie's knowledge of the subject two years ago, but if he did not, he has made a wonderfully good use of his time since that date. "Has not all he now knows in connexion with the narrow-gauge system been taught him on that little railway, and by Mr. Spooner, its engineer, manager, and secretary?" If so, these gentlemen—we are not sure, from the wording of the sentence, whether one or four gentlemen are alluded to—have shown very little good policy in acquiring so much information and giving it to the public through Mr. Fairlie, who, we thus are led to believe, has only acted as the mouthpiece of the authorities in Wales.

We are asked: "Is it not the fact that Mr. Spooner has publicly advocated narrow-gauge railways for the last six or ten years, and, what is of much more importance, brought it to greater perfection year by year?" We are not acquainted with the form Mr. Spooner's advocacy has taken beyond desultory letters, and possibly occasional contributions to different papers; useful work in any important cause consists of no half measures, but the earnest, unflagging, constant devotion of years, in which neither time, nor energy, nor means are spared. These are what Mr. Fairlie has given, and what Mr. Spooner has not, and, however earnest Mr. Spooner may have been, the world can only judge by results, not by intentions. But to that gentleman and to Mr. Carl Pihl—if we may couple the engineer of a few miles of mineral tramway, built and designed by his father, with that of a gentleman who has given his country a national system of passenger and goods railways—we have always wished to accord a full share of merit; to the latter for being the first and only engineer who, many years since, saw the advantage of narrow-gauge lines, and developed them in the most economical and practicable form; to the latter for having given every facility upon the line he has in charge, to those engineers who wished to study out the question, and for being one of the first to see the advantages to be derived from the adoption of increased locomotive power.

Mr. McKie is in error in supposing that we have ever stated that the success of the narrow-gauge system is due to the introduction of the Fairlie system, although Mr. Spooner has given the world to understand that the success of the Festiniog Railway is due to that cause, and his judgment in adopting it saved his company the expense of doubling the railway, because by its use he has been able to double the capacity of the single pair of rails.

We quite agree with Mr. McKie that Mr. Fairlie did a great service to the railway world—and to all the world—in inducing the Russian and Indian Commissions to come and inspect the Festiniog Railway: it was the first great step towards progress and reform, and achieved only by a world of labour and perseverance, with which Mr. Spooner, the engineer, the manager, and the secretary, had nothing to do, although, of course, much credit is due to Mr. Spooner for the facilities he afforded to the Commissions, a service which the Emperor of Russia very properly appreciated at its true value, and acknowledged by a presentation medal. The attempt to dissociate Mr. Fairlie's name from the 3 ft. gauge, is characteristic of the whole letter. We are well aware that such a gauge has been proposed before, nay, we believe that short lines of such a gauge have been built, but the fact is lost sight of, that credit is due not to the person who makes a suggestion, but to the one who follows it up, develops it, puts it into a practical shape, brings it into use. And herein lies the great difference between Mr. Spooner and Mr. Fairlie, the one inheriting the embodiment of an original idea from his father, affords the opportunity for the other to learn how much may be done upon a system of which that idea is but a very imperfect type; who then, putting his experience into shape, does the world real service. Mr. McKie has evidently a fixed notion that the Festiniog Railway is the parent of the narrow gauge system; nothing could be more erroneous: it has been simply the cradle of that system, in which it has been nursed and strengthened—a very different matter; it served to show to a limited extent what could be hoped from narrow gauge lines properly adapted for general traffic, and so far it has done an important service; so far, too, we recognise the good Mr. Spooner has rendered the world, but no further, and the facts we stated are by no means affected by the counter statements of Mr. McKie, statements which, if we afforded the opportunity, would be repeated in our columns by a score of claimants, all of whom could doubtless show proofs more or less plausible, why they should be considered the true authors of narrow gauge railway reform.

STONE CAISSONS.

ON Wednesday last, a number of gentlemen, including in their number General Strachey, Mr. Juland Danvers, Mr. A. M. Rendel, Mr. W. J. Thornton, Mr. J. Cubitt, Mr. C. Hawkesley, and others, were received at the works of the Ransome Patent Stone Company, by Mr. H. Bessemer, the chairman, to inspect some stone caissons now being made, to be used in the construction of the quay at Hermitage Wharf, near the Thames Tunnel pier. The opinion universally expressed was favourable to this new application of the Ransome stone, but of course the test of experience must be applied before any definite conclusion can be arrived at. If, however, it should be found successful, and we have little doubt it will, this application of Mr. Ransome's stone, made under his patent of last year, and fully described by us in the last volume of ENGINEERING, page 31, to the construction of foundations for piers, bridges, river walls, and all kinds of hydraulic works, will be possessed of the most important advantages, which can scarcely be over-estimated.

The rapidity and ease with which blocks of any form, and the sizes of which are limited only by the means available for handling them, can be produced upon the spot where they are to be employed, are advantages sufficiently great to warrant their adoption. And when, in addition, it is remembered that the materials which form the base of the Ransome stone exist in most instances in embarrassing quantities upon the site where hydraulic works are carried on, and that these, by the combination of other elements, are converted almost immediately into a stone, the strength of which is surpassed only in a small degree by granite, it will be admitted the advantages obtained are almost incalculable. This application of Mr. Ransome's process has been suggested by Mr. Butler for two reasons: the first, to provide a cheap and thoroughly efficient substitute for stone for hydraulic works; the second, to render unnecessary the construction of false works, coffer-dams, &c., and to avoid the employment of iron cylinders and caissons, now of necessity so extensively used.

In order to obtain perfectly reliable data as to the powers of resistance of Mr. Ransome's stone, a valuable and exhaustive series of experiments was recently carried out, and the result of these experiments showed that the average power of the stone to resist a crushing force was 3.19 tons to the square inch. It should, however, in justice be remarked that this average was reduced by the fact that some of the stone blocks tested were composed of materials which necessarily gave a comparatively low result, and that the average strength of the stone manufactured in the ordinary manner, gave an ultimate strength of 4 tons per inch, which may be assumed as the average strength of the stone.

Compared with some of the best natural constructive materials, the strength of the Ransome stone stands thus:

Granite, resistance to crushing 8000 to 12,000 lb. per square inch.

Portland stone, 2630*l.* per square inch.

Bramley Fall, 5120 lb. per square inch.

The Ransome stone, 8960 lb. per square inch.

It will thus be seen that the Ransome stone is, so far as strength is concerned, one of the most suitable of all building materials, and being perfectly homogeneous, it is thoroughly reliable. With regard to its durability, it is sufficient to point out that its constituent elements, and the manner in which the concretion of the entire mass is effected, guarantee for it a hardness and durability scarcely to be met with in any other material, whilst its uniformity of colour and texture render it also peculiarly suitable for the new purposes for which it is now being applied.

In practice, the materials forming the stone will be moulded *in situ* into blocks, either solid or cellular, of the required shape and dimensions. The cellular blocks form, however, the special peculiarity of this system. For bridge piers and abutments the blocks may be rectangular or circular, for dock and river walls they may be square or hexagonal—in fact, any required shape may be given them. If found advisable, they may be stiffened internally with iron braces, but this would be seldom necessary, as the strength of the material will be found sufficient, unless in very exceptional cases. For convenience in sinking the blocks, (an operation which is precisely similar to that employed in sinking iron cylinders), the lower edge of the bottom length would be chamfered, and, when necessary, shod with iron. The horizontal joints would be made preferably with alternate projections and depressions in the sides of the blocks, and the vertical joints are made good with timbers halved into each block. But these joints may be effected in a variety of ways, which need not be specified here.

What is specially urged for this system is, that it is a simple and reliable utilisation of material thoroughly adapted for the purpose, that it provides a cheap and efficient substitute for the present costly means of sinking foundations, and it is confidently believed that by its application a great revolution will be effected in the construction of hydraulic works.

It need scarcely be explained that, in nearly all cases, the stone blocks, or caissons, form their own coffer-dams, whilst in those exceptional instances, where temporary works are required, their extent and cost would be reduced by the new system.

It is also evident that there are few circumstances under which the process described, or modifications of it, would be inapplicable, whilst its cost, even under the least favourable condition reduced to half that of the existing modes of construction, would, in situations where skilled labour is scarce and materials and the means of transit costly, be further reduced to a far larger extent.

On another page we give an illustration showing the general form of the stone caissons, and the method adopted in sinking them.

COMPOUND BLOWING ENGINES.

WE give this week a two-page engraving of a very fine pair of compound blowing engines lately constructed by Messrs. Kitson and Company, of Leeds, for the Lackenby Iron Company's works near Middlesbrough. These engines have high and low pressure cylinders 32 in. and 60 in. in diameter respectively, the stroke in both cases being 4 ft. 6 in. The blowing cylinders are 80 in. in diameter and are placed below the steam cylinders, the arrangement of the valves, &c., being clearly shown in the vertical section. The engines are fitted with a surface condenser, the air and circulating pumps being worked from the crosshead of the low pressure engine through the intervention of rocking levers. The engines have been built from the joint designs of Mr. A. C. Hill, the engineer of the Lackenby Iron Works, and Messrs. Kitson and Company, and provision has been made for working either engine independently if required. It is, we understand, the intention of Mr. Hill to read a paper on these engines during the ensuing meeting of the Institution of Mechanical Engineers at Middlesbrough, and we then hope to have something further to say concerning the details of their construction and performance.

CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—The annual meeting of the members of this society was held on Friday last at their room, 4, Westminster Chambers, when the report of the council was considered. It congratulated the members on the satisfactory condition of the society and the merit of the papers read during the session. Votes of thanks were then passed to the outgoing President, Mr. James B. Walton, A.I.C.E., the Treasurer, Mr. Arthur C. Pain, and the Secretary, Mr. Charles H. Rew. The following were then elected office bearers for the ensuing year:—President, Mr. Arthur C. Pain A.I.C.E.; Vice-Presidents, Messrs. G. J. Crosbie Dawson, A.I.C.E., and Charles W. Whitaker; Members of the Council, Messrs. R. M. Bancroft, F. E. Cooper, W. Meakin, F. Lea, A. Tyrrell, A. Walmisley and G. W. Wilcocks; Honorary Treasurer, Mr. Charles H. Rew, Honorary Secretary, Mr. H. E. Hunt. Mr. J. Wagstaff Blundell was re-elected Honorary Accountant. The meeting was then adjourned until the opening of the next session on the first Friday in December.

NARROW GAUGE RAILWAYS.

TO THE EDITOR OF ENGINEERING.

SIR,—In your paper of the 30th ult. you have a leading and able article on the above subject, which you have justly advocated in place of the old and standard gauge of 4 ft. 8½ in. and other broad gauge railways. I fully agree with your views, and have read with pleasure the able and exhaustive articles you have written in your publication from time to time on the subject of narrow gauge lines; but I was greatly surprised, and so must have been many others who are acquainted with the subject, and I should think no one more so than Mr. Fairlie himself, in reading the above article, to find you had dubbed him the originator of this important reform in railways, which is rightly receiving the attention and action due to it in all countries. Before I can agree with you that the credit is due to Mr. Fairlie, I should like to have (to use your own words) "the clearest and most uncontrovertible facts that he is the true author of the railway reform."

Is it not the fact that Mr. Fairlie knew nothing of the true merits of the working narrow gauge railways until he saw the Festiniog Railway two years ago, but which line had been in full working order as a locomotive railway six years before that time? Has not all he now knows in connexion with the narrow gauge system been taught him on that little railway, and by Mr. Spooner, its engineer, manager, and secretary? Has Mr. Fairlie ever laid out a narrow gauge, or had anything to do with the management of one? Could he speak with any practical knowledge of a line of this description, excepting what he has been able to learn like every one else who has had the opportunity of seeing the line in practical work?

Is it not the fact that Mr. Spooner has publicly advocated narrow gauge railways for the last eight or ten years, and, what is of much more importance, brought it to greater perfection year by year? And has not Mr. Carl Phil been doing the same in Norway, so that the system has been fully tested years before Mr. Fairlie ever dreamt of it? Captain Tyler, the Government Inspector of Railways, advocated the system since he inspected the Festiniog Railway in 1865. Mr. Fairlie only appears on the scene when one of his bogie engines is placed to work on the Festiniog Railway. The mistake now made is in trying to make out that the whole subject of the narrow gauge system owes its success to the Fairlie engine, but this is the greatest fallacy, as the traffic on the Festiniog Railway was carried on successfully for many years before the Fairlie engine was first introduced, not but what the Fairlie locomotive for working the traffic of such lines is a great improvement. No one can be more ready than myself to give every credit to Mr. Fairlie for introducing his double bogie engine. I do not think anything could be designed better suited to work heavy traffic up steep gradients and over sharp curves, and he undoubtedly did a great service to the railway world in inducing Royal Commissions to come to England to examine the working of the Fairlie engine, not but what parties from America and other countries were continually coming over to inspect the Festiniog line before that time. The results obtained by the Commissions proved beyond doubt the advantages of that engine on both broad and narrow lines where there is heavy traffic and steep gradients. The different commissions were so convinced of the value of narrow gauge railways by seeing the satisfactory working of the Festiniog Railway, that they all decided on adopting the system for their own country, though only some reported in favour of working them with the Fairlie engine, and the Emperor of Russia was so much pleased with the valuable information and attention shown to the Russian Commission by Mr. Spooner, that he has presented him with a massive gold medal. Mr. Fairlie also deserves great credit for the able pamphlets he has written on the subject, thus making the matter more widely known.

It is worth inquiring who first advocated steam power on the Festiniog Railway; the present Mr. Spooner's father, who first laid out the line, reported in favour, and looked forward to the time arriving when the traffic would justify the needed expenditure for converting it into a locomotive railway, and as to the gauge of 3 ft. you mention as "Mr. Fairlie's gauge," I may name that Mr. Sharpe, about ten years after, seeing the Festiniog line, and consulting with Mr. Spooner as to gauge and particulars of its working, published a pamphlet in which he strongly advocated a 3 ft. gauge, and in France I laid out three different railways for him, and I believe he has advocated the making of narrow gauge lines ever since.

I trust you will excuse this lengthy letter, but I do think the credit is due to these gentlemen, Mr. Phil and Mr. Spooner, for practically carrying out the narrow gauge system, and for furnishing the world with information which, after a lifetime of labour, with scarcely a single engineer to encourage them, has resulted in the present great railway reform.

I am, Sir, yours truly,
H. U. MCKIE.

Tremadoc, North Wales, July 13, 1871.

[The subject matter of the above letter being purely personal, we can insert no further communications concerning it.—ED. E.]

LEVIS AND KENNEBEC RAILWAY.—Work has been commenced on this line. The road, when completed, will give Quebec direct communication with Portland, Maine. The total length of the Canadian portion of the line will be 85 miles.

BRAZILIAN STEAM NAVIGATION.—A Brazilian Southern Coast mail service, under a postal contract between the Brazilian Government and Messrs. Lamport and Holt, of Liverpool, commences with the current month. The service will be carried on by the steamers Calderon and Camoes. Messrs. Lamport and Holt are represented at Rio de Janeiro by Mr. Norton.

TREDGOLD'S ELEMENTARY PRINCIPLES OF CARPENTRY.

TO THE EDITOR OF ENGINEERING.

SIR,—Our attention has been directed to a review in your columns of the 7th inst., of a so-called edition of the above work, which edition is indeed, as your reviewer truly remarks, the work of Mr. Hurst and not of Mr. Tredgold.

This so-called edition of Tredgold—so far as it is Tredgold's at all—is taken from the second edition published 42 years ago (1829), and, therefore, contains none of the valuable and extensive copyright improvements and additions of Peter Barlow comprised in the third edition (1840), fourth edition (1853), and the still further enlarged fifth edition (1870). Intending purchasers of the genuine standard work of Tredgold, with its copyright additions, would, therefore, do well to order Barlow's edition, and to see that they are not misled by the title-page of Mr. Hurst's book.

You will not fail to observe that, copyright running, according to the existing law, for forty-two years, Messrs. Spon have lost no time in appropriating the first edition the moment it was deprived of legal protection. We say nothing of the morality of the proceeding, and its legality, according to the letter, may perhaps be maintained, but in the publishing trade such a proceeding is neither generally practised nor is it recognised as honourable.

We do, however, remonstrate against Mr. Hurst's preface, where you will find that he appears to wish to convey the impression that since the publication of that edition of 1829 no improvement had been made in the work, that, in fact, it had remained either non-existent (out of print) or untouched these forty-two years, "a considerable time," says he, "having elapsed since the publication of the second edition of this work. . . . A new edition, which should embrace recent improvements and examples, was much required." Lower down he says, "Several new plates and woodcuts have been added." Your readers will be amused to learn that *the whole* of the plates and woodcuts are new, the only difference being that by far the larger number are copied, without permission or acknowledgement, from the genuine copyright book, for which the author received large sums, and which we purchased, at considerable cost, from the author's late publisher, Mr. Weale.

We are, Sir, yours very truly,
LOCKWOOD AND CO.

7, Stationers' Hall-court, July 17, 1871.

TITANIUM AND IRON.

TO THE EDITOR OF ENGINEERING.

SIR,—In your issue of last week a misprint has crept into my letter. Instead of "Russian iron" it should be "Bessemer iron." Please correct the word in your next issue.

I am, Sir, yours truly,
E. TATE.

Middlesbrough, July 18, 1871.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Owing to the Glasgow annual fair holidays there was no market on Friday or Monday, but when business was resumed yesterday the market was very strong when it was learned that last week's shipments had reached an enormous total. A good business was done at 58s. 10½d. to 59s. cash, and 59s. 1½d. to 59s. 3d. one month. It closed sellers 59s. prompt cash, and buyers 59s. 3d. one month. The shipments for last week were not only good, they are the largest on record, and considerably above what was anticipated. They are, foreign, 16,506 tons, coastwise, 6823 tons, total, 23,328 tons, indeed the total is greater than the weekly make. Same week last year, 8794 tons. Total shipments for 1871, 433,975 tons; 1870, 353,816 tons, showing an increase for the week of 14,534 tons, and for the year up to this date, of 80,059 tons. In consequence of the above favourable returns the makers of special brands have already, this week, raised their prices. Gartsherrie, No. 1, being quoted at 66s., No. 3, 58s. 6d.; Eglinton, No. 1, 58s., No. 3, 57s., showing a rise of 6d. all round. Coltness, No. 1, 66s. 6d., 6d. up, No. 3, 59s., 1s. up; Langloan, No. 3, 58s. 6d., 1s. up; Glengarnock, No. 1, 62s., 1s. up, No. 3, 58s. 6d., 6d. up; Monkland, Chapelhall, 68s., being 2s. up; Shotts, No. 1, 64s. No. 3, 60s., both 1s. up. There is no doubt that the gradual rise in price, recently reported from week to week, in Scotch pig iron, is caused by the legitimate demand both for home consumption and for exportation, and not by over speculation, as is often the case. A very large portion of the pig iron shipped last week was destined for the United States, Canada, and the Continent. The imports of Middlesbro' pig iron into Grangemouth last week were 1880 tons; same week last year, 390 tons, increase, 1490 tons. Total imports for 1871, 42,512 tons; to same date last year, 35,385 tons. Total increase for 1871, 7127 tons. The market to-day has been somewhat easier, closing 58s. 10½d. cash, and 59s. 1½d. one month, sellers asking a shade more.

New Coal Cutting Machine.—Mr. John Alexander, the manager at Gartsherrie, has invented a new coal-cutting machine, which has just been put in operation, great results are expected from the two which are already at work in Messrs. William Baird and Co.'s pits.

The Edinburgh Tramways Company.—It is reported that Messrs. Croall, the extensive omnibus proprietors, have bought 10,000*l*. worth of stock in the Edinburgh Tramways Company, and that Mr. Rowbotham, lately of the North British Railway, will be manager of the company.

Preparations for the Tay Bridge.—These preparations actively continue. The foundations for three piers of the bridge on the south side have now been excavated. The contractors have also taken a lease of a quarry in Fife for the supply of freestone.

Steam Cultivation and Scottish Agriculture.—The recent interesting trials of steam cultivating apparatus at the Royal Agricultural Society's Show at Wolverhampton are likely to have an immense influence on Scottish agriculture, as it is stated that the Scottish Steam Cultivation Association either have already ordered, or about to order, from the Messrs. Fowler and Co., of Leeds, who carried all before them with their steam ploughs, no less than 10,000*l*. worth of cultivating tackle and engines.

The Edinburgh and Districts Water Trust.—The works committee of this Trust met yesterday and approved of a report upon the St. Mary's Loch Water Bill prepared by those of their number who had the Parliamentary management of the defeated Bill; and it is to be submitted to a meeting of the whole Trust to-day. The Committee were unanimously of opinion that the evidence of the opposition as to the enormous waste and large additional supply still available from the Pentlands, on which the Lords' Committee arrived at their decision, ought at once to be tested. For this purpose they were agreed as to the expediency of instructing Mr. Leslie, their consulting engineer, to secure the co-operation of Mr. Forman, the discoverer of the "intercepting scheme," so that he might point out the source from which he proposes to secure his 7,000,000 gallons per day, and the process by which it is to be collected and distributed at the cost of 190,000*l*. The Committee were further of opinion that the resident engineer, Mr. Stewart, should secure the co-operation of Mr. Ayris, of Norwich, to investigate into the nature and extent of the alleged waste by the citizens, and to obtain from Mr. Ayris his plan for the additional water fittings and apparatus which landlords should be called upon to introduce.

Glasgow Water Works.—Engineer's Quarterly Report.—At the ordinary fortnightly meeting of the Glasgow Water Commissioners, held on Monday last, the quarterly report by Mr. J. M. Gale, the engineer, was submitted. It stated that the quantity of water in store in the lochs on the 8th inst. was sufficient to maintain the supply to the city and the compensation to the river Teith for a period of 95 days. On the same date the Mugdock reservoir contained 18 days' water for the city, and the Gorbals reservoirs 93 days' water, at the rate these works are being drawn upon. These quantities are less than at the corresponding date last year, but they are greater than at the same date in 1869. The quantity of water sent into the city and district during April, May, and June last, averaged 27,000,000 gallons a day from the Loch Katrine works, and 3,800,000 gallons a-day from the Gorbals works—making a total of 30,800,000 gallons a-day. The population within the whole limits of the district supplied now amounts to 595,700, so that the average daily consumption per head during the last three months amounts to nearly 52 gallons. During these three months, however, there is always more water used than during the rest of the year; and taking the average over the last six months, the consumption per head per day is 50 gallons.

Death of an Edinburgh Engineer.—On Friday last Mr. James Newlands, for upwards of twenty-five years the engineer and surveyor of the Liverpool Corporation, died in that town. Mr. Newlands only retired from the active duties of his post a few weeks ago, retaining a salary and the position of consulting engineer. The deceased gentleman was a native of Edinburgh, and was educated at the High School and University of his native city, where he subsequently practised for some years as an architect and civil engineer. He was one of the most practical and experienced sanitary engineers; and his efforts to improve the health of the British army in the Crimea (where he seriously injured his own) induced Miss Florence Nightingale to write to him, "Truly I may say that sanitary salvation came to us from Liverpool." Mr. Newlands was a gentleman of considerable literary attainments, and he contributed largely to the "Encyloprædia Britannica."

The Ironstone Mines at Tomintoul.—The Hill of Leith, near Tomintoul, Banffshire, has been known for a number of years to contain a large quantity of hematite ironstone. A few years ago it was worked to some extent, but owing to the distance of the mines from the nearest railway—17 to 20 miles—it could not compete successfully with the Cumberland hematite. Recently the deposit has again been carefully examined by a gentleman of great experience in mining, and his opinion is that it is both rich and plentiful. The Duke of Richmond is the owner of the land on which the ironstone occurs, and I understand that there is a company ready to treat with the duke with a view to the construction of a branch railway and the development of the mines.

Transfer of the Perth Gas Works.—In accordance with the provisions of the Act of Parliament recently passed, the two gas works in Perth have now passed, or are about to pass, into the hands of the Police Commission, the members of which met as as a gas commission on Friday last. It is expected that the necessary arrangements will be completed in time for the formal transfer to be effected on the 1st of January, 1872. At present the gas is being sold at 5s. 10d. per thousand cubic feet, but it is intended to make a reduction of 4d. shortly after the works have been formally transferred to the Gas Commission.

TO CORRESPONDENTS.—Owing to the space taken up in the present number by our account of the Wolverhampton Show, we are compelled to postpone until next week, the publication of several letters already in type.

THE INSTITUTION OF CIVIL ENGINEERS.—The Members of Council and the Students of the Institution of Civil Engineers have been invited by Colonel Clarke, R.E., the engineer to the new Portsmouth Dockyard Extension, to visit those extensive and most interesting works on Monday the 31st of July. We trust that this invitation will be thoroughly responded to, for there are no works at present in progress that will so well repay inspection. A full description and detailed illustration of the dockyard extension was published in ENGINEERING, Sept. 2, 1870, and in several subsequent numbers.

FOREIGN AND COLONIAL NOTES.

Brazilian Telegraphy.—Dr. Andres Lamas and Senor Pedro S. Lamas have obtained an exclusive concession of a privilege for laying a cable between Rio de Janeiro and the river Plate. The concession is granted for a period of 40 years, and at the expiration of that time, the Brazilian stations and that part of the cable off the Brazilian coast are to belong to the Brazilian Government, which has also the option of purchasing the enterprise at the end of 10 years. Two years are allowed for the construction of the cable.

Detroit River Tunnel Company.—This company has been organised, and Mr. J. F. Joy has been elected president. The works are expected to be soon commenced and trains will probably be passing through the tunnel within two years.

Population of New York.—New York is shown by official returns which have just been compiled to have a population of 942,293 inhabitants, of whom 929,199 were white and 13,093 coloured. Of the 929,199 white inhabitants, 510,553 were born in the United States and the remainder in foreign countries. Of the foreign born inhabitants of New York, 201,999 were Irish, 111,955 Germans, 54,398 English, and 8240 French.

Madras Railway Bridges.—Another bridge on the Madras Railway has given way. In this case the structure which has failed is on the Bellary branch of the company's system, and it is familiarly known in the Presidency as the Veerapoor bridge. The goods traffic on the branch is suspended for the present, while the usual shifts are resorted to in connexion with the passenger traffic.

Canadian Railways.—Constructive operations are being vigorously prosecuted on the Levis and Kennebec and the Sorel and Drummondville Railways by Mr. Hulbert, the contractor. About 500 men are now employed upon the former line, and 700 upon the latter.

Pennsylvanian Steel Rails.—The Pennsylvania Steel Company's works near Harrisburg are now producing Bessemer steel rails at the rate of 14,000 tons per annum. This production would steel rail annually about 140 miles of single line.

Railways in New South Wales.—An extension of the Great Northern Railway of New South Wales from Aberdeen to Scone has been formally opened. The New South Wales Government has not submitted any scheme to the Colonial Legislative Assembly for railway extension or for other means of improved communication with the interior. The Western and Northern lines have not yet been completed to Bathurst and Murrarundi. The various extensions on hand appear to be progressing tolerably well.

The German Navy.—It is expected that great increase in the German fleet will be made during the next few years. In addition to three turret vessels, of which two are to be built at the dockyard at Kiel, and one by the Vulcan Company at Stettin, seven corvettes are to be constructed at Dantzic, and are to be all finished by 1877.

Gas-Lighting at Campos.—Messrs. Dutton, Traga, and Wilmot have entered into a contract for lighting the streets of Campos (Brazil) with gas.

Telegraphy in Victoria.—The amount of revenue derived from telegrams by the Victorian Government, in 1870, was 33,145*l.* This total showed a falling off of 1038*l.*, as compared with the corresponding figures for 1869.

Constantinople Tramways.—A line of tramway between Azap Capou and Beschitash will shortly be opened for traffic. The cars which will be run are from the workshops of a well-known Vienna builder. A Stamboul line from the Yeni Dami mosque to Ak-Serai has been nearly completed.

American Patents.—Commissioner Leggett has been hearing, at the Patent Office at Washington, arguments for and against an application for an extension of patent rights to Mr. William Kelley, of Kentucky, for purifying iron by forcing up and through it atmospheric air while the iron is in a molten state. The remonstrants were numerous railway companies and iron manufacturers, the latter principally from Pennsylvania. The commissioner took the papers, and reserved his judgment. The case is, of course, of interest and importance to all iron and steel manufacturers

Brazilian Railways.—A company for carrying out a line between Jundiahy and Itu has been advertising for tenders for the construction of the line. The tenders were to be opened June 25, so that it is possible that a commencement has since been made with the works.

British Columbian Pines.—Pines of almost incredible size are met with in British Columbia. Trees often measure 320 ft. in height, two-thirds without a branch. The masts to be had on Vancouver Island are superior in flexibility and density to the best from Riga.

New Zealand Railways.—The works of the Great Northern Railway of the province of Canterbury (New Zealand) are progressing towards Kaiapoi. The fencing is complete to the Styx, and the provincial government has invited tenders for the erection of an iron girder bridge over the north branch of the Waimakariri.

Chilian Telegraphy.—The Chilian Government has resolved to proceed with the construction of three additional lines of telegraph. These lines will extend from Nacimiento to Los Angelos, Quiribue to Cauquennes, and Petorca to the main northern line.

The East River Bridge.—Recent advices from New York state that the construction of the tower for the East River Bridge between New York and Brooklyn is making rapid progress. Nine courses of masonry have been laid, rising to a height of 20 ft. above the water.

Railways in Victoria.—The Victorian House of Assembly has appointed a committee to report upon the Fairlie and other alleged economical railway systems. A contract for the second portion of the North-Eastern of Victoria, 60 miles in length, has been let to Messrs. Styles, Murray, and Co.; the first section of this line, which is 56 miles in length, is expected to be ready for traffic in March, 1872.

Another Great American Bridge.—Locomotives have now passed over a great iron railroad bridge over the Ohio, at Benwood, which has been in course of construction for two years. The bridge is nearly three-fourths of a mile in length. The channel span is 350 ft. wide and 95 ft. above low-water mark, while it contains 600 tons of iron. The approach on the Ohio side is by an arcade of 41 arches, which is considered a very fine piece of masonry. The arches of the arcade are 40 ft. from centre to centre.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the Middlesbrough iron market was well attended. Like the previous week there was again a great demand for iron to complete the cargoes of steamers waiting to proceed to sea, and makers who could deliver pigs immediately, got about 6d. per ton more than the ruling quotations, which are as follows: No. 1, 51s. 6d.; No. 2, 50s. 6d.; No. 3, 48s.; and No. 4, 47s. Both the home and foreign demand for pig iron continues good, and makers are still sold forward for many months.

The Finished Iron Trade.—All the works are as busy as possible in the various branches of this trade, and from the orders which are coming to hand, they are likely to be kept in this satisfactory state for some time to come. Inquiries for rails are numerous, and additional contracts are being secured by Cleveland firms. In consequence of the prosperous state of the shipbuilding trade, there is a capital demand for plates and angle iron. Bars, bolts, nuts, and screws find a ready market.

Shipbuilding.—On the Tyne, Wear, and Tees all the ship yards present a busy appearance. There are a great number of vessels of all sizes in various stages of progress. On Monday Messrs. Backhouse and Dixon, Middlesbrough, launched an iron screw steamer 132 ft. long, 20 ft. broad, and 11 ft. 1 in. deep. She was christened the Sixty-six. Messrs. Blair and Co., Stockton-on-Tees, will fit her with engines 40 horse power, and she will shortly proceed to take a share of general trading for a Middlesbrough firm.

Engineering.—On Tees-side there is a large amount of blast-furnace engineering being done. All the marine-engine builders in the North of England have as much work on hand as they can get through, and engineers generally are exceedingly busy. There is, however, still a scarcity of bridge-work.

The Co-operative Engine Works at Newcastle.—The Co-operative Engine Works, Cuseburn, Newcastle-on-Tyne, to which we referred last week, are to commence operations on Monday next. It is stated that they will be worked on the nine hours' system.

The Scotswood Bridge Company.—The annual meeting of this company was held this month. For the year ending June 30 the annual net income amounted to upwards of 2000*l.* A dividend of 10 per cent. was declared.

The Newcastle College of Physical Science.—Subscriptions for the purpose of establishing this college have been most liberal. So well has the undertaking proceeded that arrangements have been made for the opening of the college in October next.

The Steel Works at Gorton.—These works, which are situate near Manchester, and which were recently purchased by Messrs. Bolckow, Vaughan, and Co., the great iron-makers, Middlesbrough, have been altered and started as Bessemer steel works.

The Middlesbrough Dock.—The desirable extension of this dock is being rapidly proceeded with. The Chamber of Commerce have recommended the North-Eastern Railway Company to continue the quay well on the south side of the dock; to erect good substantial warehouses and proper sheds on the south-eastern side of the dock entrance, and to procure a powerful set of shear legs for loading heavy goods and machinery on the north side of the existing entrances. These suggestions are now receiving the attention of the railway directors.

The Institution of Mechanical Engineers.—In addition to the information we gave last week respecting the forthcoming visit of the Institution of Mechanical Engineers to Middlesbrough, we now append a list of papers which will be read on Tuesday and Wednesday the 25th and 26th inst. The subjects and the names of the gentlemen who will read the papers are as follows: "On the Manufacture of Hematite Iron," Mr. William Crossley, of Askam-in-Furness; "On the Preliminary Treatment of the Materials Used in the Manufacture of Pig Iron in the Cleveland District," Mr. Isaac Lowthian Bell; "Description of the Improved Compound Cylinder Blowing Engines at Lackenby Iron Works, Middlesbrough," Mr. Alfred C. Hill; "On the General Geological Features of the Cleveland Mining District," Mr. John Jones, Middlesbrough; "Description of the Brake Drums and the Mode of Working at the Ingleby Incline on the Rosedale Branch of the North-Eastern Railway," Mr. John A. Haswell, Gateshead; "On a Simple Construction of Steam Engine Governor, having a Close Approximation to Perfect Action," Mr. Head, Middlesbrough; "On Steam Boilers with Small Water Space and Root's Tube Boiler," Mr. Charles Cochrane, Middlesbrough; "On the Breakage of Axles Under Railway Rolling Stock," Mr. Edward Fletcher, Gateshead; "On the Principal Constructions of Breechloading Mechanism for Small Arms and their Relative Mechanical Advantages," Mr. William G. Marshall.

The Nine Hours' Movement.—During this week Mr. Joseph Cowen, jun., and Mr. Charles Mark Palmer have been attempting to bring the masters and men together so that a conference might be held, and, if possible, the strike in the engineering trade ended. Up to the time of writing, we are sorry to say we have not heard of the endeavour being attended with success. Certainly the masters have consented at last to meet the men on certain conditions. The men may probably attend a joint meeting, but we fear they are not likely to relax in the least their determination to continue on strike until the nine hours' movement is adopted.

NOTES FROM THE SOUTH-WEST.

The Colliers' Strike in South Wales.—On Saturday evening, a third instalment was paid by the Amalgamated Association of miners to the colliers now out on strike in South Wales. The total amount distributed was 861*l.* 13s. 8d., which was divided between 5307 men at the rate of 3s. 2d. to each man. The number of men claiming from the union funds is decreasing. The first instalment remitted by the association amounted to 1048*l.* 6d. which was divided between 9222 men at the rate of 2s. 2d. each. The second instalment amounted to 881*l.* 4s. 8d., and was divided between 8734 men at the rate of 1s. 11d. each, so that the number of men claiming assistance from the association has much decreased. It will be seen that the assistance doled out by the association during a period of six weeks amounts altogether to 7s. 3d. per man, or just 1s. 1d. per week.

Steam Line between Cardiff and New York.—A project for the establishment of a line of steamers between Cardiff and New York is said to be on the tapis. It is proposed to effect this object by means of a limited liability company, with shares of 1000*l.* each. The Marquis of Bute it is affirmed is favourable to the project, the realisation of which does not appear, however, to be by any means assured at present.

Carpenters' Strike at Gloucester.—A number of carpenters have been on strike at Gloucester. They ask that their wages shall be advanced from 25s. to 27s. per week, and that they shall leave work on Saturday at one instead of two o'clock. The masters are said to be not indisposed to make an advance on the pay of the men, but they refuse to consent to any alteration in the hours of work.

Exports from Cardiff.—The average quantity of coal sent from Cardiff to foreign ports monthly is about 160,000 tons. Last month the total fell, according to the Custom House returns just published, to 67,906 tons, this unfortunate result being wholly due to the strike among the steam coal colliers of South Wales. In May the exports of coal from the port amounted to 227,600 tons. The quantity of iron shipped from Cardiff in June amounted to 18,000 tons, of which 10,000 tons were sent to New York.

The Avonside Engine Works.—On Saturday evening, Mr. Abraham Jefferies, late foreman of the forge department at the Avonside Engine Works, was presented with a handsome gold watch and chain and an address. Mr. Jefferies was foreman of the forge department for 17 years and was a workman for 13 years previously. The number of subscribers to the testimonial was about 500, and included the foremen, workmen, and draughtsmen of the Avonside Engine Company.

Welsh Railways.—The Midland Railway Company will establish communication shortly with Swansea by means of the Swansea Vale and Neath and Brecon Junction Railways. A short branch, which will connect the Rhymney Railway with the Great Western system, will be completed by the end of this month.

The Forest of Dean.—The iron trade of this district continues active. The coal trade is steady and is expected to display increased animation.

Swansea Harbour Trust.—The revenue of the Swansea Harbour Trust shows a surplus of income over expenditure for the past year of 3632*l.*, the principal portion of this surplus having occurred during the past six months. The increase is expected to continue as the importation of iron ore from Spain will probably attain still further importance.

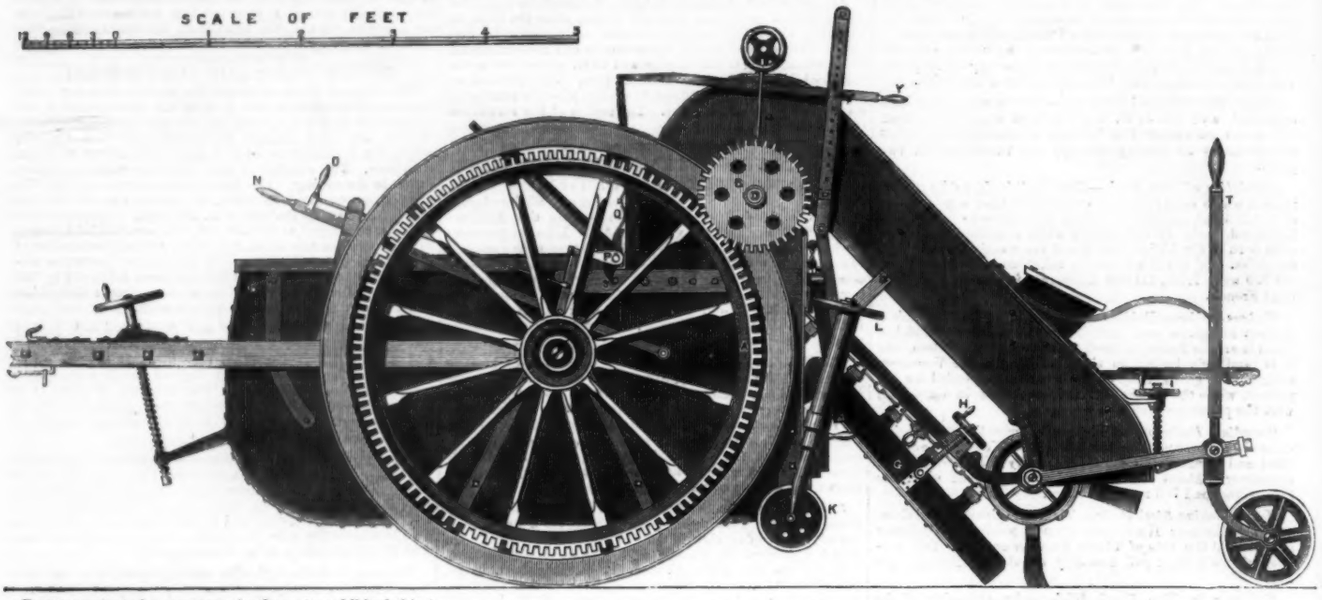
Sewage Utilisation at Taunton.—The Taunton Board of Health has resolved to purchase for 700*l.* a field for the purpose of utilising the sewage of the town.

Taff Vale Railway.—The receipts of this line continue to be much affected by the unfortunate strike still continuing among the steam colliers of South Wales. The last weekly traffic return shows a collection of only 426*7l.*, as compared with 6793*l.* in the corresponding week of 1870.

THE BRITISH ASSOCIATION.—The arrangements for the meeting of the British Association in Edinburgh are now nearly completed. The sections will be accommodated in the various class-rooms of the University, and it is expected that the great hall of the Parliament House will be used as a reception room. The first general meeting of the association will be held in the Music Hall on Wednesday evening, the 2nd of August, at 8 o'clock, when Professor Huxley will resign the chair, and Professor Sir William Thomson will assume the presidency and deliver an address. On Thursday evening, the 3rd of August, a lecture will be delivered in the same place by Professor Abel, F.R.S., on some recent investigations and applications of explosive agents. On Friday evening, the 4th of August, a soirée will be given by the Professors of the University. On Monday evening, August 7, a discourse will be delivered in the Music Hall by Mr. E. B. Tylor, F.R.S., on the relation of primitive to modern civilisation; on Tuesday evening, August 8, there will be a soirée in the Museum of Science and Art; and the concluding general meeting will be held on the afternoon of Wednesday, the 9th. On Thursday, the 10th, a number of excursions will be made. The officers for the Section G—that devoted to mechanical sciences—are: President, Professor Fleeming Jenkin, C.E., F.R.S. Vice-Presidents—Professor Rankine, F.R.S., L. and E., Thomas Stevenson, C.E., F.R.S.E. Secretaries—H. Bauerman, F.G.S.; Alexander Leslie. C.E.; J. P. Smith, C.E.

WARREN'S STREET SWEEPING MACHINE AT THE WOLVERHAMPTON SHOW.

CONSTRUCTED BY THE BRISTOL WAGON COMPANY, BRISTOL.



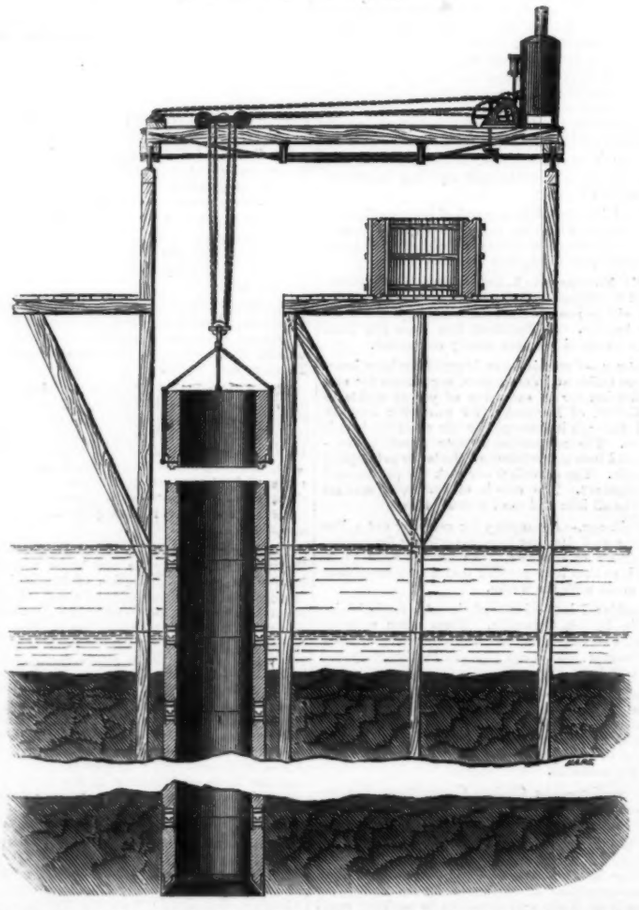
FROM amongst the numerous implements exhibited this year by the Bristol Wagon Company, we have selected for illustration Warren's street-sweeping machine, as embodying a new arrangement, and one which has already given great satisfaction at Cheltenham. The machines usually employed for sweeping and hauling mud from roads and streets, are all combined, in other words, the mud cart and the apparatus for working it, are contained in one and the same implement. Thus, after the mud cart has been charged, the old system necessitates the transit of the machine, as well as of the cart, to the place where the sweepings have to be deposited. According to Mr. Warren's plan, on the contrary, the cart can easily be attached to, or detached from, the machine, as we shall describe presently, by an operation occupying only a few minutes of time. By this arrangement, therefore, much time, as well as a corresponding outlay incurred in the purchase of a greater number of combined machines, can be saved; it is evident, also, that Warren's sweeping machine can be kept almost continually at work, being sufficient, in fact, for from five to ten carts, according to distance of the tipping place.

The apparatus we are describing, and which we illustrate on the present page, is furnished with two sets of brushes, working independently of one another on separate shafts, while in the ordinary machines of this kind but one set of brushes is provided for. The former plan allows the sweeping of a total width of 4 ft. 2 in., and as the brushes work loosely on the shafts, and not as a fixture to the cart, they can easily adapt themselves to all the inequalities of the ground. Each set of brushes is worked from the road wheel nearest to it, whereby the turning of the machine is greatly facilitated; the set of brushes, of course, stopping with the wheel on the side to which the cart is turned.

We will now describe the manner in which the sweeping portion of the apparatus is detached and attached. Referring to our engraving, a pair of small wheels, K, will be noticed, which can be lowered by means of the hand wheels, I. These wheels are made to support the apparatus after having been detached from the cart, and in order to do this, the lever, N, is first raised, and the handle, O, pulled forward so as to disengage the catch, P. As soon as this has been effected, the spring, Q, releases the pawl from its fastening, S, when the cart can be taken away, and another instantly be attached by merely raising the lever, Y, and by repeating a similar operation as in disengaging. The hand wheels, I, lower the brushes as they become worn, while the shute, G, can be raised to suit the brushes by means of the hand wheels, H.

RANSOME'S STONE CAISSONS; BUTLER'S PATENT.

(*For Description, see Page* 47.)



CANADIAN PACIFIC RAILWAY.—Mr. Moberly, C.E., and Mr. Lennan, C.E., have left Ottawa for British Columbia, to undertake the surveys of the Canadian Pacific Railway in that quarter. Two routes are to be run, one through the Leatherhead Pass in the Rocky Mountains to the Pacific coast, and the other through the House Pass. Mr. Moberly and a couple of parties will explore the former route, commencing nearly 460 miles from the Pacific; and Mr. Lennan and a couple of parties will explore the latter, or northern, route, through the House Pass. The following gentlemen have been appointed to take charge of other surveying parties:—Mr. G. B. Lloyd, Mr. J. P. O'Hanley, Mr. W. A. Austin, Mr. C. H. Gainsby, Mr. B. D. M'Connell, Mr. H. A. Armstrong, Mr. J. G. Johnston, Mr. J. Fleming, Mr. H. E. Carre, Mr. C. James, and Mr. E. W. Jarvis.

INDIAN, &C., HARBOURS.—Mr. Robertson, C.E., in a letter to the Governor of Madras, states that he considers that the preparation of eighteen reports upon the harbours which he has inspected will keep him fully employed until the next season, when he will return to India. Mr. Robertson points out that by visiting the harbours during fine weather he was able to accomplish boating and coast work which would have been impracticable at other times, and that he was also able to examine the bars of rivers' mouths when in their worst state.

BAUSCHINGER'S INDICATOR EXPERIMENTS ON LOCOMOTIVES.

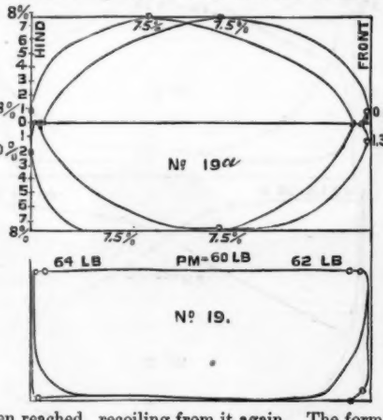
(*Continued from page* 18.)

WE will now proceed to explain the construction of the diagram showing the action of the valve gear which is annexed to each set of indicator cards, and which is called by Professor Bauschinger the distribution diagram.

As an example, we will select the distribution diagram referring to the first "notch" of the mixed engine, A, illustrated at the head of the series of diagrams belonging to that engine given on the next page. These, and all the other diagrams we illustrate, are, we may mention, drawn to one-half their original size. The points at which the supply of steam is cut off, in this case, are at 14 per cent. and 19 per cent. of the stroke (hind and front end respectively), as ascertained from the valve motion diagram. The line, *o z*, represents the stroke, and parallel to this line are drawn, also half size, the steam ports for the admission and release, the former above and the latter below, *o z*. We will now assume the piston to move on its stroke from the front to the hind end, or from *z* to *o*. Having arrived at a point, *a*, near the hind cylinder end, the valve opens the port to admit the steam, which, at the end of the stroke, is admitted to the amount, *o*, *b*, called "hind pre-admission." The piston begins now its return stroke, at the commencement of which the opening of the port still increases a little, till the maximum opening is reached at *c*, corresponding to the position of the piston at *y*. From this point, the valve begins to close the port again, and when the piston is at a point, *d*, the supply is cut off and expansion takes place till a point, *e*, is reached, marking the opening of the valve to the exhaust, which, at the end of the stroke is open to the amount, *z*, *f*, termed by the professor the "pre-release." As the piston moves again from *z* towards *o*, the exhaust opening still increases till *g*, and becomes shut when the piston has arrived at *h*. From this point, the piston compresses before it the steam remaining in the cylinder, till it has arrived at *a*, when the valve opens the port again for the pre-admission, and when the same process begins again. In a similar manner the other distribution diagrams contained in our illustrations explain the action of the slide valves for the various degrees of expansion, while the subjoined Table contains further information which could not be conveniently given on the diagrams themselves. Before proceeding further, we wish to call attention to the dotted lines shown in the diagram just described. These lines refer to curves which would have been obtained with an ordinary slide valve, and show already clearly the advantages presented by the auxiliary steam passage of the Trick or Allen valve.

We will now examine the form of the indicator curves with reference to the principal periods of the steam distribution, here again following the course of Professor Bauschinger's observations:

(*a*) Lead or pre-admission. To insure a good action of the steam it is essential that the maximum cylinder pressure be attained at the very commencement of the stroke. If this is the case, the admission line of the indicator diagram—the piston being at the end of the stroke—will rise in a vertical line, neither receding from it nor, after the vertical has



been reached, recoiling from it again. The former defect is particularly the case with the shifting link motion when working at a high degree of expansion as shown in diagram No. 1, while in diagrams Nos. 9 and 10, taken at the 6th and 8th notch respectively, the admission line recoils slightly from the vertical. Under the circumstances of diagram No. 1 the area of the opening for pre-admission is 2.5 per cent. of the piston area (as shown by the scale) and for the moderate speed at which the engine was running, this amount of lead is, no doubt, too much; in diagrams Nos. 9 and 10, on the other hand, a pre-admission of from 1.1 to 1.6 per cent. of the piston area would appear much too small, even in the latter case where the engine was making but 54 revolutions per minute.

In this respect the curves obtained with the Meyer valve gear show a marked distinction, which will already be apparent by a mere inspection of the distribution diagrams. The series of curves taken from the goods engine, *g*, show that, in the case of Meyer's motion the amount of pre-admission remains constant for all degrees of expansion. That the amount of lead, in this case, was insufficient, is clearly shown in the diagrams by the admission lines withdrawing from the vertical lines which mark the end of the stroke. Constant lead involves also constant compression, and this latter seems to have been avoided as much as possible in the engines, E, F, and G, with the Meyer gear as shown by the diagrams and also in Table II. The deficiency of lead in this case appears, therefore, all the more faulty, as both elements, lead and compression, regulate the admission. If the clearance spaces at the beginning of the admission are already filled with compressed steam, a less amount of lead is necessary and *vice versâ*. With the shifting link motion, however, not only the lead but also the compression increases rapidly as the link approaches mid-gear; but considering the high speed at which the engine is usually running in mid-gear, this phenomena does not prove a drawback as the increased compression is calculated to facilitate greatly the attainment of the full pressure of steam in the cylinders at the commencement of the stroke.

Furthermore, it should be remembered that a good admission of the steam depends, not only on the amount of lead, but also on the commencement of it, or, in other words, on the period at which the valve opens the connexion with the steam chest preparatory to the next stroke of the piston. Thus, on examining the distribution diagram taken at the second notch of engine, A, it will be seen, that the pre-admission begins when the piston has yet 4 per cent. of the length of stroke to travel, while the amount of lead is 2.2 per cent. of the piston area. When the Meyer valve-motion is employed, Professor Bauschinger recommends an amount of lead of 2 per cent. of the piston area, and also that the lead should begin at 3 per cent. of the stroke before the dead point is reached, and that the compression should amount to, at least, 10 per cent. of the length of the stroke. These data depend, of course, on the amount of stroke and angular advance of the eccentric, on the lap of the valve, &c.

In our next number we shall examine the indicator curves with regard to the element of admission.

(*To be continued.*)

TABLE No. IV.: REFERENCE TO DIAGRAMS ON THE PRESENT AND FOLLOWING PAGE.

Class of engine.	System of valve motion.	Distribution diagrams. Reference number.	Degree of expansion, or notch.	Period of admission in per cent. of stroke. Hind end of cylinder.	Front end of cylinder.	Indicator diagrams. Reference number.	Number of revolutions of driving wheel per minute.	Mean speed of piston, in feet, per second.	Amount of regulator opening.	Amount of opening of blast pipe orifice.	Mean boiler pressure, in pounds, per square inch.	Maximum cylinder pressure. Hind end. In pounds per square inch.	Hind end. In per cent. of boiler pressure.	Front end. In pounds per square inch.	Front end. In per cent. of boiler pressure.	Mean cylinder pressure (P. M.) in pounds per square inch.
A	Stephenson...	1*a*	1st	14	19	1	119	7.9	¼ open	¼ shut	94	88	94	92	98	80
						2	144	9.6	¼ open	open	71	40	56	40	56	7
		3*a*	2nd	19	27	3	85	5.7	¼ open	open	116	113	98	112	97	57
						4	124	8.3	¼ open	open	90	87	97	87	97	40
						5	84	5.6	¼ open	¼ shut	115	109	95	108	94	72
		5*a*	4th	33	43	6	79	5.3	¼ open	¼ shut	126	120	95	122	96	74
						7	94	6.3	¼ open	open	125	122	98	120	96	81
						8	94	6.3	¼ open	shut	117	113	97	117	100	66
		9*a*	6th	49	60	9	75	5.0	¼ open	open	120	108	90	108	90	85
		10*a*	8th	62	71	10	54	3.6	starting	open	95	79	83	77	81	68
		11*a*	0	31	28	11	108	7.2	½ open	open	108	58	54	56	52	35
						12	160	10.7	½ open	open	93	53	57	52	56	28
		13*a*	⅛	40	39	13	107	7.1	½ open	open	102	72	70	67	66	47
						14	134	8.9	½ open	open	106	57	54	55	52	37
G	Meyer	15*a*	⅛	58	57	15	83	5.5	½ open	open	107	46	43	42	39	35
						16	128	8.5	½ open	open	117	46	39	45	38	33
						17	92	6.1	open	open	110	95	86	93	84	73
		19*a*	⅛	96	97	18	96	6.4	open	¼ shut	105	91	87	90	86	64
						19	...	...	starting	open	115	64	56	62	54	60

THE ART OF TURNING.

WE have received the following circular just issued by the Worshipful Company of Turners, and we have much pleasure in publishing it as it refers to a matter likely to interest a number of our readers:

The master, wardens, and court of assistants of the Worshipful Company of Turners, in continuance of their action last year, propose to give, each year, their silver medal and the freedom of the company and of the City of London to any one workman or apprentice in the trade who may send in the best specimens of hand turning for the year.

The material to be used will be varied in different years, so as to include wood, ivory, metals, stone, spar, &c. The competition for this year will be in turning in wood.

The following are to be the conditions of the competition. The qualities which will be considered in awarding the prize will be the following, viz.:

1. Working to exact dimensions, illustrated by a cylinder 6 in. long and 2 in. in diameter, or any other object which shall measure exact inches without fractions.

2. Exactness of surface and fit, such as is shown by a nest of cylindrical boxes with screwed lids, which shall drop out of one another and fit without shake; but these qualities may be otherwise illustrated at pleasure.

3. Exact copying, so that the two objects produced (such as two cups, vases, boxes, or chessmen) may be facsimiles in every part.

4. Neatness of design, symmetry of shape, and good form of mouldings.

5. Fitness of the work and design for the purpose proposed.

6. Ability to turn in different woods, of varied grain and degree of hardness.

The candidate may make his own selection from the above list; but the one who best fulfils the largest number, including the most important qualities, will be preferred. The work must be all hand turning, produced in the ordinary lathe, without special apparatus. The different objects must be delivered free at the Mansion House, London, during the week beginning Monday, October 2nd, and ending Saturday, October 7th.

Specimens must not exceed 18 in. in height and a foot in diameter. They must be each marked with a private mark or motto, and numbered, and accompanied by a list, showing for each number the grounds on which the prize is sought. They must be accompanied by a sealed envelope marked with the same mark or motto, and containing the name and address of the competitor, and his age, if an apprentice, and in all cases a certificate of good conduct, and a certificate or declaration that he is in the trade and that the work is by his hands only. These will not be opened until the judges have made their report.

The specimens sent will remain the property of the competitor; care will be taken of them, but the Court will not hold themselves responsible for their safety. The candidates must remove the specimens at their own cost within a week of the decision being communicated to them.

The successful candidate last year was Alfred Madden, 59, Peabody-buildings, Commercial-street, Shoreditch.

The judges were the following citizens and turners: Mr. Charles Hutton Gregory, Past President of the Institution of Civil Engineers; Mr. John J. Holtzapffel, Assoc. Inst. C.E., Engine, Lathe, and Tool-Maker; and Mr. John Jaques. The Right Honourable the Lord Mayor of London has kindly consented to present the prize for 1871.

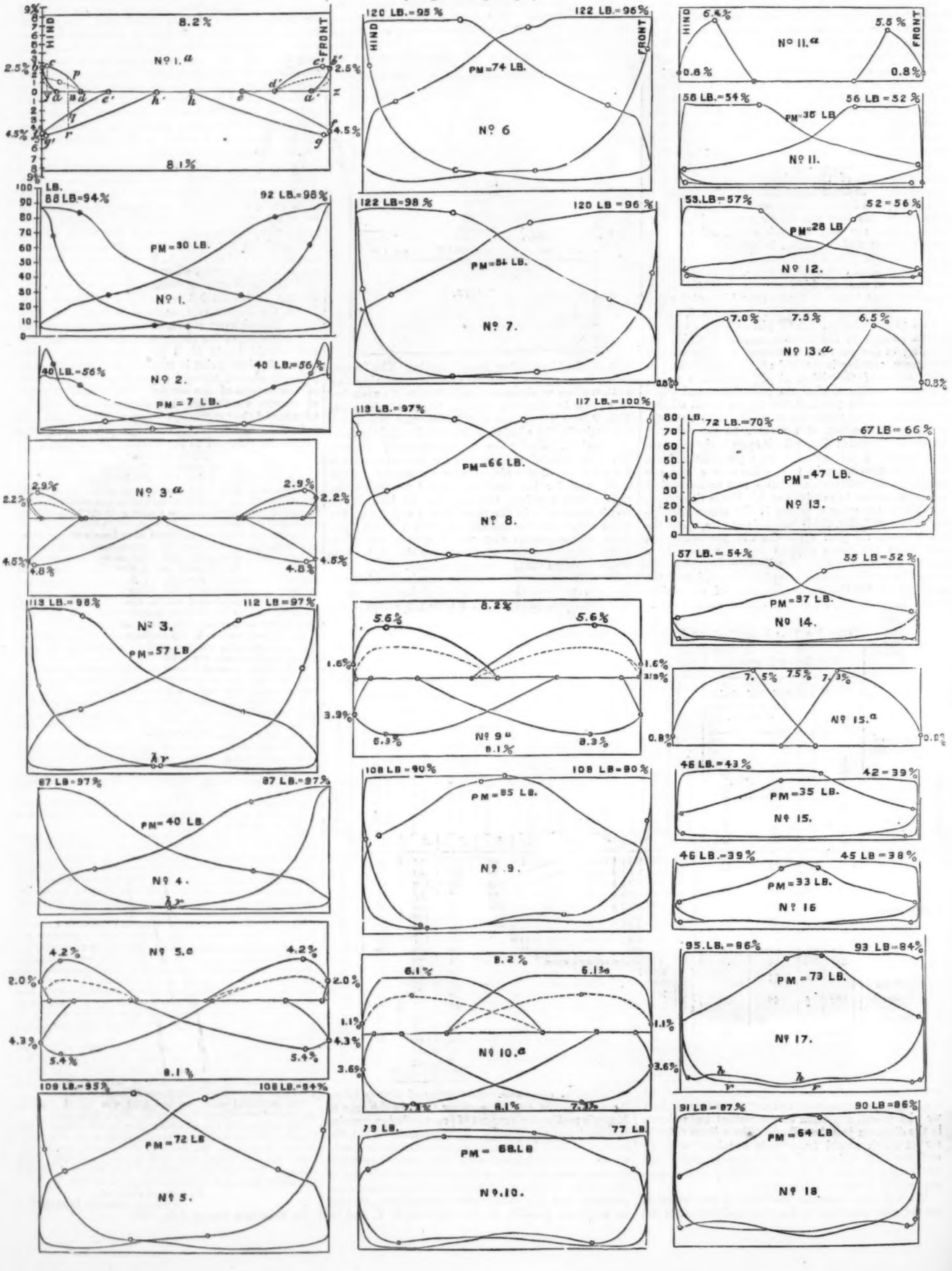
By order of the Court,

CHARLES IRELAND SHIRREFF.

59, Mark-lane, London, July, 1871.

BAUSCHINGER'S INDICATOR EXPERIMENTS ON LOCOMOTIVES.

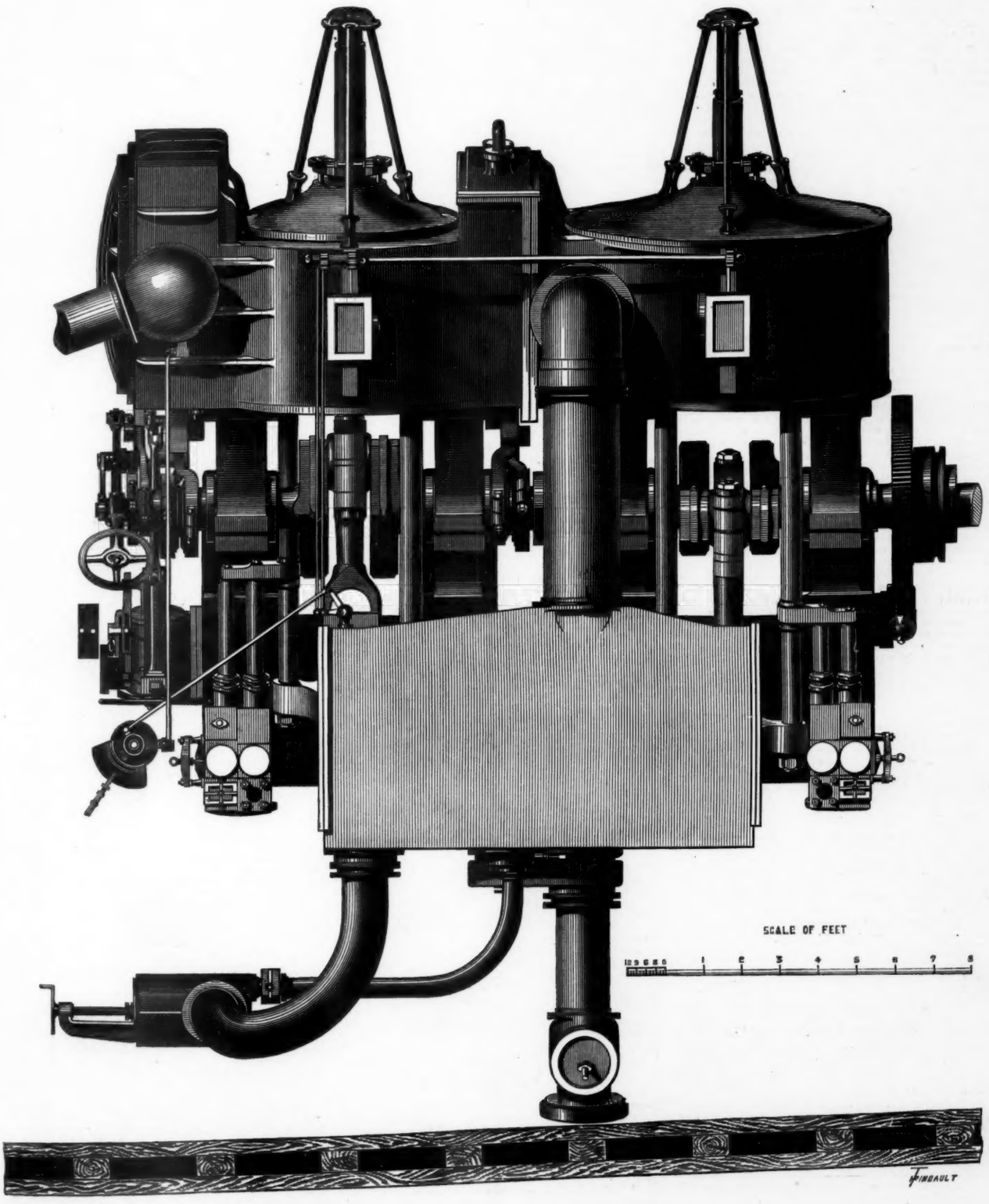
(*See preceding Page.*)



COMPOUND SCREW ENGINES OF H.M.S. "TENEDOS."

CONSTRUCTED BY MESSRS. JOHN ELDER AND CO., ENGINEERS, GLASGOW.

(*For Description, see Page* 56.)



MANUFACTURE OF HEMATITE IRON.*

By MR. WILLIAM CROSSLEY.

In the hematite districts of Lancashire and Cumberland, owing to the peculiarities of the materials employed and other causes, it has not been practical to make use of all the most recent improvements in the working of blast furnaces, or to keep pace with the rapid progress effected elsewhere; but it is thought a description of the results obtained elsewhere may not be altogether out of place in a district like Cleveland, where the manufacture of iron is carried on in the most scientific manner and with the most approved appliances. The furnaces of the hematite district are much the same as those at work in Cleveland, but the appliances for working them are not usually so good. Those at work at Barrow may be taken as a fair type of most hematite furnaces as to size and capacity. They are about 55 ft. high, and 15 ft. diameter at the boshes, having a capacity of about 9000 to 10,000 cubic feet. The furnaces at the Furness Iron and Steel Works, Askam, with which Mr. Crossley is connected, are 67 ft. high and 19 ft. wide at the boshes, tapering to 18 ft. below the gas outlet, and have a capacity of 13,100 cubic feet, which is greater than that of any other hematite furnace at present working. The various attempts which had been made to work larger furnaces for hematite ores do not seem to have been attended with such success as to justify the erection of others, and one or two instances where furnaces of 75 ft. have been erected, the results obtained have been so unsatisfactory that the furnaces have been blown out, and the height diminished to 55 or 50 ft. The Askam furnaces of 67 ft. did not work well for some time when they were first blown in, and the cause of their bad working was attributed to the smallness of the charging bells in proportion to the width of the furnaces, and consequently larger bells were substituted. The bells at first employed were only 7 ft. 6 in. diameter, but the present ones are 12 ft. 6 in. diameter, and these are believed to be the largest of any yet used for hematite furnaces. These furnaces now work with great regularity, and each produces weekly from 400 to 460 tons of iron, a large proportion being Bessemer converters. For taking off the blast furnace gas the bell and hopper arrangement adopted in the Cleveland district has not been found to answer so well in the hematite furnaces; the Carnforth and the Askam Works are the only two places at which this plan is adopted. The reasons for not adopting it at the other places are—first, that it is believed to act prejudicially upon the quality of the iron produced; and, secondly, that it throws a heavier back pressure upon the furnaces, and thus interferes with their regular working. The furnace at present building at Askam is expected to be ready for working in a couple of months. It is 75 ft. high, 23 ft. diameter at the boshes, and has a bell 14 ft. in diameter. The object in adopting these dimensions was to ascertain whether the same advantages would result from increased height up to 75 ft. which has been obtained in Cleveland. The arrangement for charging the furnace is usually adopted where the gas from hematite furnaces is utilised, and which was found to take off a large proportion of gas to the stoves and boilers. The blast ore of Whitehaven and Furness does not differ much in quality, but there can be no doubt that the best Whitehaven ores are richer than the best Furness ores. The ore used at Askam has the following composition: Peroxide of iron, 83.00; silica, 15.50; carbonate of lime, trace; moisture, 1.50; total, 100.00; per centage of metallic iron, 58.10. Three principal varieties of Irish ores are used in the manufacture of hematite iron, which are fairly represented by the ores known as lithomange, red aluminous iron ore, and black nodular iron ore.

The analysis of these ores is as follows:

	Lithomange.	Red aluminous.	Black nodular.
Silica	30.70	11.25	6.0
Alumina ...	27.05	35.61	20.37
Titanic acid ...	trace	trace	0.75
Peroxide of iron	25.05	34.65	71.63
Protoxide ...	trace	trace	0.68
Magnesia and lime	1.11	trace	trace
Water of combination	15.88	16.30	1.15
Metallic iron ...	17.35	23.25	50.14

As to the alleged failure, the explanation was to be found in an improper distribution of materials, owing to the bell not being suitably proportioned to the size of the furnace throat. The lime used at Askam is obtained from a neighbouring quarry, and the coke used is obtained almost entirely from the Durham coalfield, and is usually of the very best description.

The analyses of the limestone as well as of Askam pig and of slag from Askam No. 2 furnace are subjoined:

Stainton Limestone.

Carbonate of lime	95.0
,, magnesia	4.2
Oxide of iron and alumina	0.3
Silica	0.5
	100.0

Slag from Askam No. 2 Furnace.

Silica	38.00
Alumina	10.00
Lime	42.19
Magnesia	1.65
Sulphuret of calcium	2.45
Protoxide of iron	2.08
Potash	1.60
Protoxide of manganese	trace
Soda and loss	2.03
	100.00

Askam Pig.

Carbon, graphitic	3.928 ...	3.377 ...	2.719
,, combined	0.109 ...	0.469 ...	1.222
Silicon	2.640 ...	2.424 ...	1.608
Alumina ...	trace ...	trace ...	trace
Manganese ...	0.093 ...	0.021 ...	0.021
Calcium	0.021 ...	0.050 ...	0.074
Magnesium ...	trace ...	trace ...	trace
Sulphur	0.004 ...	0.004 ...	0.031
Phosphorus ...	0.014 ...	0.010 ...	0.016
Iron	93.191 ...	93.645 ...	94.309

In working a material so difficult to deal with as the hematite ore, the first and most important point to be attended to is the proper distribution of the materials in the furnace. In open-topped and semi-closed furnaces that is easily done by keeping the furnace always full to the same height, and putting in small charges in regular rotations. In close-topped furnaces the object is accomplished either by taking care to have the bell properly apportioned to the diameter of the furnace as previously mentioned, or by gauging at frequent intervals with an iron rod, in order to make sure that the materials shall never be above or below the height which experience has proved to give the most satisfactory results. Another point worthy of attention is the small percentage of carbonic acid in the escaping gas, which seems to indicate either that the ore is not so easily reducible as has generally been supposed, or that, owing to its compact nature, the gases do not ascend with the regularity which is obtained in Cleveland furnaces.

* Abstract of a paper read before the Institution of Mechanical Engineers at Middlesbrough.

PRIVATE BILLS IN PARLIAMENT.

Upon the assembling of the Peers in the House of Lords on the 13th inst., the Royal assent was given by commission to the following Bills: The Aberdeen Harbour Bill, the Sutherland and Caithness Railway Bill, the Bristol and Exeter Railway Bill, the Great Southern and Western and Cork and Limerick Direct Railway Company's Bill, the North British Railway Bill, the Vale of Clyde Tramway Bill, the Brecon and Merthyr Tydvil Junction Railway Bill, the Great Western Railway (Steam Vessels) Bill, the London and North-Western Railway Bill, the Micheldean Road and Whimsey Railway Bill, the North-Eastern Railway Bill, the Aldborough Harbour and Railway Bill, the Margate Pier and Harbour Bill, the Wharves and Warehouses, Steam Power and Hydraulic Pressure Company Bill, the North British, Arbroath, and Montrose Railway Bill, the Finn Valley Railway Bill, the Glasgow (City) Union Railway Bill, the Southampton Docks Bill, the London, Chatham, and Dover Railway Bill, the Clyde and Cumbrae Lighthouses Trust Bill, the Waterford and Wexford Railway Bill, the Holborn Viaduct Station Bill, and the Bristol and Portishead Pier and Railway (Portishead Docks) Bill. The Lords Commissioners were the Lord Chancellor, the Earl of Cork, and Lord de Tabley.

During the same week the following Bills were read a third time in the House of Lords, and passed. The Bristol Port and Channel Dock Bill, the Liverpool Tramways Bill (with amendments), the Great Northern Railway Bill, the East London Railway Bill, the Bradford and Thornton Railways Bill, the Lancashire and Yorkshire Railway (new works) Bill, the North Metropolitan Tramways Bill, and the Killorglin and Farranfore Railway Bill.

On the 14th inst., before the House of Lords Committee, the case of the Somerset and Dorset Railway Bill was open and adjourned. This is an Extension Bill to join the Midland Railway at Bath, to enter into traffic arrangements with that company, and also to enter into working agreements with the Poole and Bournemouth Railway, and to purchase the Tramways of the Somerset Coal Canal Navigation Company.

On the 17th inst., before the House of Lords Committee, the Somerset and Dorset Railway Bill was further proceeded with, Mr. Merewether, Q.C., being heard in opposition to the measure on behalf of the Great Western Railway (the principal opponents), proceeded to call Mr. Fowler, C.E., who gave evidence as to the inexpediency and inutility of the proposed scheme. The opponents' case was not concluded when the Committee adjourned. At the conclusion of Mr. Merewether's speech, the learned counsel begged their Lordships that he might be allowed to say one word personal to himself. This was the last occasion that he should have the honour of addressing a Committee of their Lordships' House, and it would be quite contrary to his usual practice and habit if he failed to express his deep sense of the uniform courtesy and kindness which he had always received from members of their Lordships' House. Mr. Merewether was the leader of the Parliamentary bar. The learned gentleman was called to the bar on the 9th of June, 1837, and received the rank of Queen's Counsel in 1853.

The preamble of the Sligo and Ballaghaderreen Junction Railway Bill was also proved and reported without amendments. The object of this Bill is to extend the time for the compulsory purchase of lands, and for the completion of the railway; to authorise the issue of preference shares; to make provision for a county guarantee on the part of the company's capital; to enable Viscount Dillon to increase his subscription, and for reciprocal running powers with the adjoining railway company. The Kent Coast Railway and the Southern Railway Bills were also before the Committee on Unopposed Bills, and reported with amendments.

Before the House of Commons Court for the consideration of *locus standi* in the case of the Isle of Wight and Cowes and Newport Junction Railway Bill the *locus* was disallowed of the Corporation of Southampton and the Southampton Chamber of Commerce, but the *locus* was allowed of the Isle of Wight (Newport Junction) Railway and the magistrates, merchants, and other inhabitants of Newport.

On the 18th inst., before the House of Lords Committee, the opposition of the Great Western Railway to the Somerset and Dorset Railway Bill was further proceeded with and concluded, Mr. Grierson, general manager of the Great Western Company, being examined. Mr. Clark, Q.C., then proceeded to call local evidence in support of the petition of the Bristol and North Somerset Railway in opposition, the engineering evidence being deferred.

Before the House of Commons Committee the preamble was proved of the unopposed Lyme Regis Railway Bill (from the Lords).

On the 19th inst., before the House of Lords Committee, the Somerset and Dorset Railway Bill was further proceeded with, Mr. Clarke, C.E., being examined in opposition. Mr. Clark, Q.C., then summed up the evidence on behalf of the Bristol and North Somerset Railway. Mr. Denison, Q.C., then replied for the promoters, observing that there were eighteen petitions in favour of the Bill. And with regard to the question of broad and narrow gauge, Mr. Fowler, C.E., who had been called by the Great Western Railway in opposition to this measure, was only a recent convert to the broad gauge, but he (the learned counsel) had had the good luck throughout in being consistent for the narrow gauge. In five years he believed on good authority that there would hardly be a bit of broad gauge on the Great Western proper. And as to the question of rates which had been raised, rates were not higher or lower because the gradients were higher. The committee-room was then cleared. On the readmission of the public the chairman said the Committee were of opinion that the preamble of the Bill was proved. The clauses were then proceeded with, some being adjourned.

The Euston, St. Pancras, and Charing-cross Railways Bill was then taken, Mr. Denison, Q.C., stating the case on behalf of the promoters. It will be remembered that the objects of this Bill are to incorporate a company for making railways to connect the London and North-Western Railway at Euston-square and the underground branch of the Midland Railway at St. Pancras with the Charing-cross Railway, and for making two new streets over the railway between Oxford-street, Leicester-square, and Castle-street. It also provides for trains for labouring classes, at fares not exceeding 1d. (in addition to Government duty), with limit of compensation, in case of accident, to 100*l*. The length of this new proposed line is to be 2 miles 48 chains, and the proposed capital is to be by shares 1,700,000*l*., and by loan 566,000*l*. Mr. Hawkshaw, C.E., was examined in support of the preamble, and the Committee adjourned.

Before the House of Commons Committee the opposed Bill from the Lords of the Isle of Wight and Cowes and Newport Junction Railway was proceeded with and adjourned. The object of this Bill is to incorporate a company for making a railway from the Isle of Wight, in the parish of Brading, and crossing the river Medina, to the Cowes and Newport Railway, on the north of Newport, and to enter into arrangements with existing companies.

On the 20th inst., before the House of Lords Committee, in the case of the Somerset and Dorset Railway Bill, the remaining clauses were agreed to. The promoters' case of the Euston, St. Pancras, and Charing-cross Railway Bill was further proceeded with, Mr. Barry, joint engineer of the company with Mr. Hawkshaw, being first examined. There were no engineering difficulties connected with this scheme, and the line, no doubt, would be a great advantage. With respect to the Metropolitan Railway traffic, that traffic has increased two millions within the last twelve months. The whole traffic of the Metropolitan Railway is 40,000,000 a year. The absence of dividend by that company has nothing to do with its traffic. Mr. Bazalgette, engineer to the Metropolitan Board of Works, said that he advised the Board that this was a good scheme. The Board of Trade are to pay a contribution of 200,000*l*. on the contemplated new street being completed. With regard to only a portion of the line being completed, in witness's opinion the line would be useless if not fully carried out. He had no doubt it would be carried out in its entirety. Local evidence was then called with respect to the necessity for the contemplated new street and its advantages. Counsel having been heard in opposition, on the part of Lord Southampton, but without calling evidence, the preamble was declared to have been proved.

Before the House of Commons Committee the Isle of Wight and Cowes and Newport Junction Railway Bill was further proceeded with.

Another batch of Private Bills received the royal assent by commission in the House of Lords on Monday last. These were the Letterkenny Railway; the East London Railway; the Columbia Market Approaches and Tramways; the Bradford Canal; the Bristol Port and Channel Dock; the Liverpool Tramways; the Thames Valley Drainage; the Great Northern Railway; the Devon and Cornwall Railway; the Navan and Kingscourt Railway; the Dover Harbour; the London and South-Western Railway; the Londonderry and Coleraine Railway; the Bradford and Thornton Railways; the Lancashire and Yorkshire Railways (new works); and the Usk and Towy Railway Bills. The Commissioners were the Earl of Bessborough, Lord Sydney, and the Lord Chancellor.

The following Bills have been read a third time and passed in the House of Lords: The Ennis and West Clare Railway Bill; the Great Western Railway Bill; the Bury Port and Gwendreath Valley Railway Bill, and the Mersey Railway Bill.

In the House of Commons the following have passed the third reading: The Devon and Cornwall Railway Bill; the Dover Harbour Bill; the London and South-Western Railway Bill; the Londonderry and Coleraine Railway Bill; the Navan and Kingscourt Railway Bill, and the Birmingham West Suburban Railway Bill.

On Friday the 21st inst., before the House of Lords Committees, the opposition to the Mersey Docks and Harbour Board (No. 2) Bill was withdrawn. In the case of the Euston, St. Pancras, and Charing Cross Railways, the preamble of which was passed on Thursday last. The following are the express terms on which the Committee passed the preamble, viz., two years for compulsory purchase, and three years for completion of the works. Mr. Denison, Q.C., for the promoters, expressed their opinion that these were very hard terms. The chairman observed that the Committee did not want any expression of opinion, those were the terms upon

which the preamble was decided to have been proved. The clauses were then agreed to. This Bill, by the way, is the same which our imaginative contemporary, *The Engineer*, last week informed its readers had passed through Committee under the altered title of the London Central Railway. The alteration is a pure invention on the part of *The Engineer*, and as it has no existence in fact, we must ascribe it to an unwonted outburst of misdirected imagination. Our contemporary also refers to the success of the promoters as warranting an interchange of congratulations between them and the public. Mr. Denison did not convey this impression when he uttered the complaint we have above recorded. The preamble was also proved of the unopposed North and South-Western Junction Railway Bill (Transfer).

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The Scotch iron trade, looking at it in its present condition, or in its future prospects, has hardly ever been in a sounder state; the shipments of iron from Scotch ports, both foreign and coastwise, although expected to be a fair average, have exceeded the most sanguine expectations, and it is expected that for some weeks to come they will be large, as there is an increasing demand for freights to America and other ports. Most readers who take an interest in the iron trade will recollect that when, about this time last year, the commencement of the hostilities between France and Germany was announced, the prospects of trade, after a long depression, were encouraging, and, although prices were a little forced up by speculation, still there was every chance of a revival of all branches of trade warranting a substantial rise. Last year, although things looked well for the trade, it could not be compared with the present prosperous state of matters. There are now very much larger shipment sales. The German ports being open, a large quantity of iron will be sent over there to make up for the deficiencies caused by the war. On looking at these facts there is every reason to suppose that in the common course of events prices are likely to go on improving. Monday of last week was a holiday. On Tuesday the market opened very strong, when business was done up to 59s. cash, and 59s. 3d. one month; on Wednesday the price was hardly so good, closing sellers at 59s. cash, and 59s. 3d. one month; on Thursday a good business was done at 59s. 4½d. cash, and 58s. 6d. one month; on Friday the market was very strong, closing at 59s. 7½d. prompt, and 60s. one month, buyers 1½d. less. Some makers refuse to sell at all just now, and if the shipments keep up as is anticipated, iron must come out of store to supply the founders, as the total weekly make is only about 23,000 tons. Up to this date the stock in Connal's store for this month has been reduced by fully 600 tons, and there is a small quantity of iron going out of the Canal Company's store. The following are the prices of some of the best brands of makers' iron: Gartsherrie No. 1, 68s. 6d.; Coltness No. 1, 68s. 6d.; Langloan No. 1, 64s.; Shotts No. 1, 65s. These have all been advanced to-day. Last week's shipments were, foreign, 13,801 tons; coastwise, 5309; total, 19,110; same week last year, 8942 tons. There was a further advance on Monday and yesterday, and the market has again been strong to-day, business done at 61s. to 61s. 3d. a month, and 60s. 9d. to 60s. 10½d. cash; closing buyers at 60s. 10½d. cash and 61s. 2d. a month, sellers asking a shade more.

The Engineering Trades.—If it were at all possible, the engineering trades generally are becoming still busier. Boiler making, iron founding, bridge building, and engineering proper, are in such a state of briskness, that men cannot be obtained in sufficient numbers to execute the work in hand; and the managers in many cases scarcely know which work to attack first. In almost all cases there is scarcely the full complement of hands yet, owing to the habits of the men being unsettled by the late holidays.

North British Association of Gas Managers.—The tenth annual general meeting of this association was held in the hall of the Royal Scottish Society of Arts, George-street, Edinburgh, this day week, Mr. Hugh Bartholomew, Glasgow, in the chair. There was a pretty large attendance of managers. Five new members were added to the association. The committee reported that the successful authors of the prize essay were Mr. Innes, Forfar, and Mr. M'Pherson, Kirkcaldy. Mr. Macrae, Dundee, read a paper on "The Transfer of Gas Works from Private Companies to Corporations," which was well received. Dr. Stevenson Macadam then delivered a lecture on "The Relative Value of the Purifying Agents Employed in the Manufacture of Coal Gas," which, being able and interesting, was listened to with great attention. The meeting agreed, on the motion of Mr. Hyslop, Paisley, to raise the yearly subscription per member from 3s. to 5s. It was resolved that the next meeting of the association be held in Perth on Friday, 20th July, 1872.

Grant from the Government for Arbroath Harbour.—Information was received in Arbroath from Mr. Baxter, M.P., last week, stating that, in compliance with an application from the Harbour Trustees, Government have granted a loan of 20,000*l.* for the improvement of the harbour. The news created the utmost satisfaction in the town. The steeple bells were rung.

Laying the First Stone of the Tay Bridge.—On Saturday the first stone of the Tay Bridge was formally laid in presence of a few spectators. The first part of the structure is a land abutment—the necessary excavation for which having just been completed, it was arranged that the first stone of this gigantic undertaking should be deposited there. It may be mentioned that the bridge commences with a curve. The land abutment is raised to the height of 28 ft., so that it may be in line with the piers. The excavation for the first land pier has been completed. There is another pier on land, the foundations of which will be sunk on the beach in front of the rocks. The first three piers have each a span of 60 ft. A landing pier has been run out 160 ft. into the river, and it is intended to run another pier at right angles to increase the facilities for discharging materials. Everywhere there are evidences of activity, and there can be no doubt the work will be pushed forward as rapidly as possible. It is probable that a grand foundation ceremonial with masonic honours will take place when one of the great piers of the bridge has been sunk. The directors at a meeting on Saturday last expressed their gratification with the manner in which everything has been conducted by the contractors up to the present time, and they are very sanguine that the whole of the works will be completed within the specified time of three years. A contract has been entered into with the Falkirk Foundry Company for 3500 tons of castings, a large portion of which have been prepared, and are in course of being transmitted to Wormit Bay on the Fifeshire side of the Tay.

Greenock Water Trust.—The monthly report submitted to the Greenock Water Trustees at their monthly meeting yesterday, showed that the depth of water in Loch Thom is at present 35 ft. 8 in., and that the total quantity of cubic feet on hand is 174,318,314. The superintendent reports that the old works are in fair working order. The fencing round the embankments and new Gryfe works is now finished; and there is 38 ft. depth of water at tower of No. 1 reservoir, and 39 ft. at tower of No. 2. The works along the line of the tunnel are going on slowly, and the contractor's engines, boilers, &c., not now in use are being removed. The superintendent having been offered an appointment abroad, with a higher salary than at present, the committee recommended an increase of Mr. Wilson's salary, making it 400*l.*, should he refuse the offer.

Appointment to the Royal Military Academy, Woolwich.—Mr. John Macleod, assistant professor of mathematics in the University of Glasgow, has just been appointed mathematical instructor at the Royal Military Academy, Woolwich, by Sir L. Simmons, Governor of the Academy, with the approval of the Secretary of State for War.

The Highland and Agricultural Society's Show.—The annual show of the Highland and Agricultural Society is being held this year at Perth. To-day, to-morrow, and Friday are the show days. There is a larger display in the implement department than there has ever been before. The implements had all to be in their places by ten o'clock yesterday morning, so that the inspecting committee might proceed to examine them with the view of announcing their awards to-day.

NOTES FROM THE SOUTH-WEST.

Trade at Newport.—Rail orders have been coming in freely from the United States and Canada. The European demand appears to have also improved, but there is still only little doing with Russia. The price of rails is well supported at 6*l.* 10*s.* to 7*l.* per ton, free on board. Pig iron has displayed an upward tendency, and an improvement recently noticed in tin plates is well maintained.

Somerset and Dorset Railway.—A Bill, promoted by the Somerset and Dorset Railway Company for an extension of the company's line from Evercreech, near Shepton Mallet, to form a junction with the Midland Railway at Bath, has passed a Committee of the House of Lords. It had been opposed by the Great Western and other broad-gauge interests.

Ordnance Survey of South Wales.—At the last monthly meeting of the Cardiff Chamber of Commerce the secretary said circulars had been issued by Mr. Dalton, clerk of the peace for Glamorganshire, in which it was stated that the Board of Ordnance required notice to be given of the nomination and appointment of two or more intelligent persons in each parish to attend the Government officers, and point out the boundaries for the purposes of the new 6 in. survey.

New Lighthouse.—Mr. Levi Yerward, late Government contractor at Pembroke Dockyard, has been selected by the Trinity Board to erect a lighthouse, dwelling houses, and other offices at Hartland Point, North Devon. The height of the lighthouse will be about 185 ft. The cost of the work will be from 7000*l.* to 10,000*l.*, and it is to be completed in about fifteen months.

The Bath Stone Trade.—The Midland Railway Company intends to make special arrangements with a view to the extension of the Bath stone trade. The material will be brought to a depôt to be constructed at Bathampton, and will thence be conveyed in barges to the company's goods station at Bath.

Llanelly Railway.—Mr. W. D. Phillipps, of Llanelly, is about to sever his connexion as manager with the Llanelly Railway and Dock Company in consequence of his having accepted an appointment upon the London and North-Western Railway. He is to be presented with a testimonial by his old friends and associates of the Llanelly.

Trade at Merthyr.—The iron works in the Merthyr district continue active, and substantial orders are anticipated. The steam coal trade remains in a comparatively stagnant state, and there are but slight hopes of renewed activity.

Pembroke and Tenby Railway.—A work of some importance in connexion with this line has been commenced, viz., a new pier at Hobb's Point. The pier will enable vessels to come alongside to load and discharge cargoes. The pier is expected to be completed within six months. Mr. Davies is the contractor.

The Forest of Dean.—The iron trade is brisk in the Forest of Dean, there being an abundance of orders on hand. The firms engaged in working minerals appear to be also doing well, there being an increasing demand for Forest of Dean iron ore. The extraction of coal at the principal collieries of the Forest of Dean district continues large, and the coal trade may be pronounced active.

Welsh Shipping Movements.—The Summer Cloud has cleared from Cardiff for Dardt with 25 tons of bar iron supplied by the Llynvi Iron Company, and 132 tons of sheet iron supplied by Messrs. T. W. Booker and Co. The Ella S. Thayer has cleared from Cardiff for New Orleans with 501 tons of railway iron supplied by the Rhymney Iron Company, and 500 tons of hoop iron supplied by Messrs. T. Nash and Co. The Septentrio has cleared from Newport for New York with 303 tons of iron supplied by the Patent Nut and Bolt Company. The Constance has cleared from Cardiff for Ancona with 131 tons of bar iron supplied by the Llynvi Iron Company. The Eblana has cleared from Cardiff for Quebec with 950 tons of railway iron supplied by the Dowlais Iron Company. The Luègès Nadre has cleared from Swansea for Alexandria with 1038 tons of patent fuel supplied by Messrs. Cory, Yeo, and Co. The North-Eastern screw steamer, has cleared from Cardiff for Leghorn with 1100 tons of railway iron supplied by the Rhymney Iron Company. The May Queen has cleared from Newport for Genoa with 560 tons of iron supplied by the Ebbw Vale Iron Company. The Argo has cleared from Newport for Stettin with 470 tons of iron supplied by the Tredegar Iron Company. The Balmoral, screw steamer, has cleared from Cardiff for Rotterdam with 175 tons of sheet iron supplied by Messrs. T. W. Booker and Co.

A Tunnel under the Severn.—It is rumoured that the scheme for a tunnel under the Severn will be revived in the Parliamentary session of 1872. The object is to reduce the railway distance between the South Wales coalfield and London and the West of England.

Taff Vale Railway.—The traffic of the Taff Vale Railway continues greatly reduced by the unfortunate strike among the steam coal colliers of South Wales. The last weekly return shows a receipt of 4476*l.*, as compared with 6058*l.* in the corresponding week of 1870.

South Wales and West of England Coal and Metal Markets.—A market was held on Saturday at Swansea. Forge and foundry pig iron were stated to be in better request. Some contracts for forward delivery were reported. Hematites were in good demand, and the prices asked for Shropshire and other good brands were higher than last week. There was also a good inquiry for tin-plate bars. Refined tin was sold for 140*l.*, being the highest price which it has touched since May, 1869. Tin-plates were wanted, but the high prices asked by makers prevented business. Cornish and Devonshire iron ores are receiving much attention, and are being imported into South Wales to an increased and increasing extent.

Welsh Railway Traffic.—The Monmouthshire Railway Company appears to have commenced the current half year well as regards its traffic returns, the first fortnight having produced 6768*l.*, as compared with 6051*l.* in the corresponding period of 1870. The revenue of the Rhymney Railway is also increasing.

FOREIGN AND COLONIAL NOTES.

New York Railroad Depôts.—A new passenger depôt for the Hudson River and Harlem Railroads on Forty-second-street is rapidly approaching completion, as is also a branch railroad in Westchester county, which is to connect the two great thoroughfares. Within a few months the depôts on Twenth-sixth and Thirty-first streets will be abandoned for the newer and more attractive building.

American Narrow Gauge Engines.—The Baldwin Locomotive Works at Philadelphia, have just completed a narrow (3 ft.) gauge locomotive for the Denver and Rio Grande Railroad. It is said to be the first narrow gauge locomotive built in the United States for general passenger or freight service. The engine is six-wheeled, four of the wheels 40 in. in diameter being coupled as drivers, while the pair of leading wheels are arranged so as to enable the engine to pass short curves readily. The cylinders, which are placed outside, are 9 in. in diameter with 16 in. stroke. The total weight of the engine in running order is 25,300 lb., of which 20,500 lb. are carried on the four driving wheels. A four-wheeled tender having a water capacity of 500 gallons and a coal capacity of about 1¼ tons is attached.

Tasmanian Coal.—Messrs. Cummings and Co., proprietors of the Don Mills and Coal Mines, are engaged in opening up an extensive mine discovered some time since by Mr. Anderson Cummings. The area of the new mine has been proved over an extent of 50 acres, and the quality of the coal is superior to that obtained from the old mine as it leaves less slack. The seam, so far as it has been opened out, is 20 in. thick.

Auckland Harbour Commission.—A board of harbour commissioners has been formed at Auckland, New Zealand. The construction of a dock is talked of.

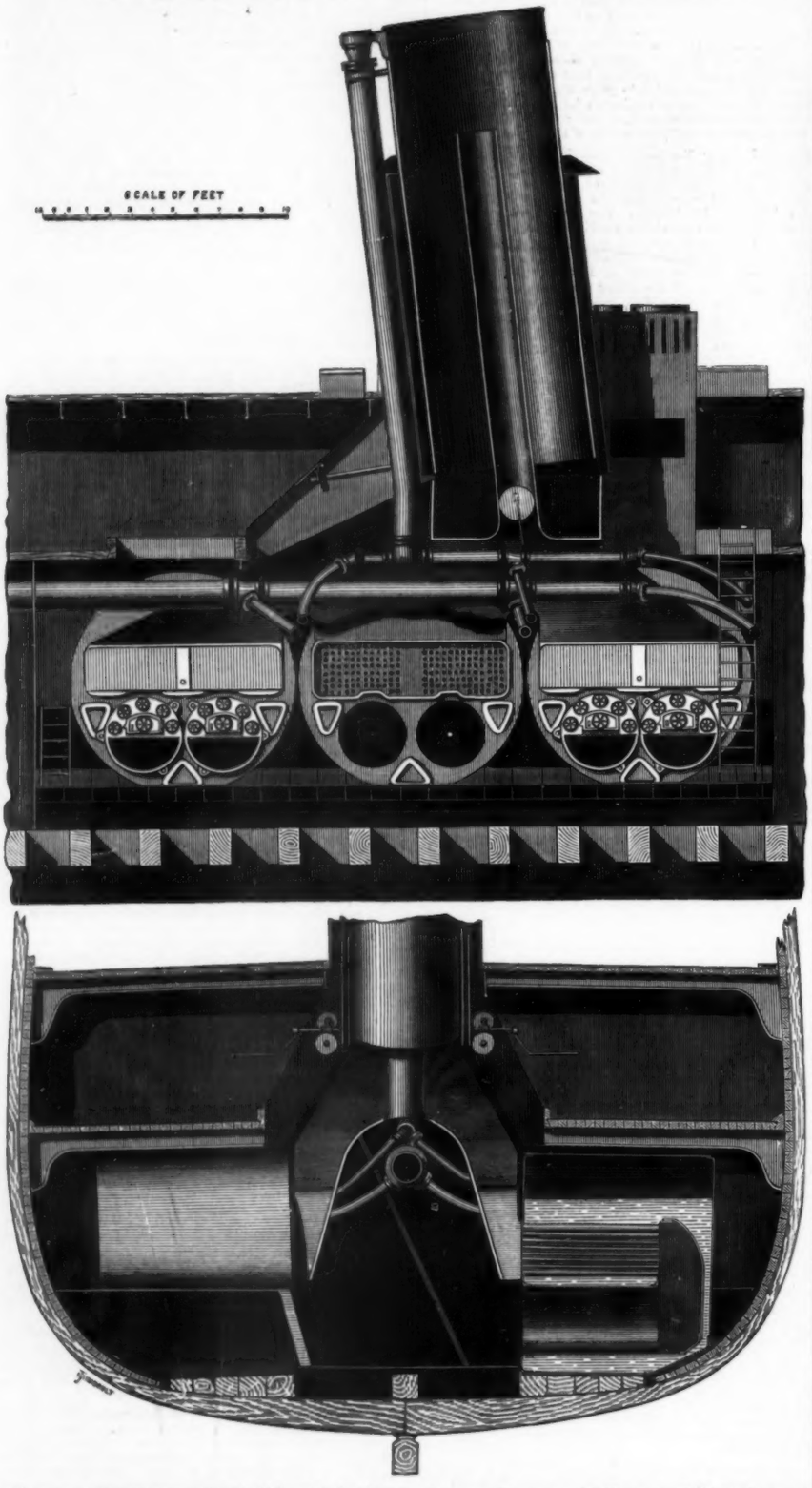
The Belgian Iron Trade.—Both refining and casting pig have been much sought after by French industrials. Orders for almost all descriptions of iron succeed each other rapidly and freely; rails alone are an exception to this remark.

Northern of France Railway.—The ratio of the working charges to the traffic receipts of this system rose last year to 46 per cent. When the war broke out, the company was working 696¾ miles of line; in December, it had only 373¾ miles in working order and under its control.

The Great Australian Overland Telegraph—Mr. C. Todd, Postmaster-General and Superintendent of Telegraphs in South Australia, states that the great overland telegraph which is being carried across the island-continent is being erected in a most substantial manner. The wire is of the best quality, specially manufactured by Messrs. Johnson and Nephew, and the insulators are of the most approved form. The bulk of the poles used on the Adelaide side are heavy gum saplings, and twenty to the mile are being planted. About 3000 galvanised wrought-iron poles have been imported for the section between 400 and 500 miles in length from Port Augusta.

BOILERS OF H.M.S. "TENEDOS."

CONSTRUCTED BY MESSRS. JOHN ELDER AND CO., ENGINEERS, GLASGOW.



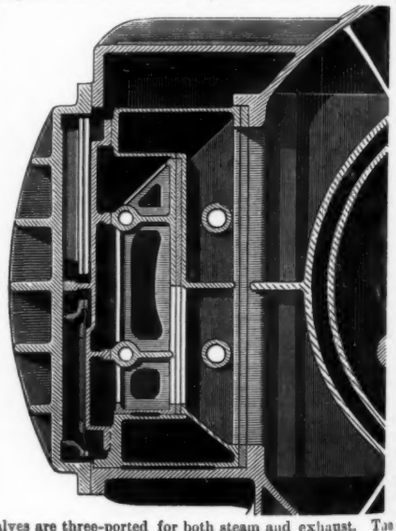
TASMANIAN TELEGRAPHY.—A line of telegraphy has been erected between Launceston and Deloraine, Tasmania. It is also proposed to extend the advantages of telegraphy to the eastern portion of the Devon district from Deloraine to the terminus of the Mersey and Deloraine line, and thence on to Latrobe and Torquay.

AMERICAN BRIDGES.—A bridge across the Mohawk river, a short distance below Schnectady for a branch of the Saratoga Railroad, has been completed at a cost of 40,000 dols. The Western Maryland Railroad Company is building a Howe truss bridge in two spans of 120 ft. each across Owing's creek, above Mechanicstown.

ENGINES OF H.M.S. TENEDOS.

WE publish this week a two-page engraving as well as illustrations on the present and opposite pages, and on page 53, showing the engines and boilers of H.M.S. Tenedos, the excellent performance of which during the official trials we had occasion to record about three months ago. These engines, which are rated at 350 horse power, nominal, are of the compound, intermediate receiver, return connecting rod type, with surface condensers, and were designed and built by Messrs. John Elder and Co., of Glasgow. The cylinders, which are slightly inclined to the horizontal, are 57 in. and 90 in. in diameter, respectively, the stroke being in both cases 2 ft. 6 in. Both cylinders with their covers are thoroughly steam jacketed, the steam being supplied to the jackets by a pipe and cock from the main steam pipe, and the water arising from condensation being discharged into the hot well. The pistons, also, are steam heated, the arrangement for admitting steam to them being as follows: The back rods, or, in other words, the piston rods passing through the back cylinder covers, have each two holes bored through them, these holes being each fitted with a sliding pipe. One of these holes serves as the steam inlet, and simply opens into the steam space in the piston; while the other communicates with the hot well, and is provided at its inner end with a pipe leading down to the bottom of the space in the piston, so that any water arising from condensation may be blown off through it.

The intermediate receiver into which the high-pressure cylinder exhausts, consists of an annular space surrounding the jacket of the high-pressure cylinder, and cast in one piece with the latter, as shown in the section on the present page, which will also serve to explain the arrangement of the valves and passages. The large cylinder is fitted with a single slide, while the valve of the high-pressure cylinder is equilibrated, and is fitted with an expansion valve on the back, as is shown in the subjoined section. Both the



valves are three-ported for both steam and exhaust. The main valves are driven by link-motion in the usual way, and a third pair of eccentrics with link-motion is provided for working the expansion valve, this last link-motion being adjusted independently by the arrangement of reversing screw shown in the end elevation contained in our two-page engraving.

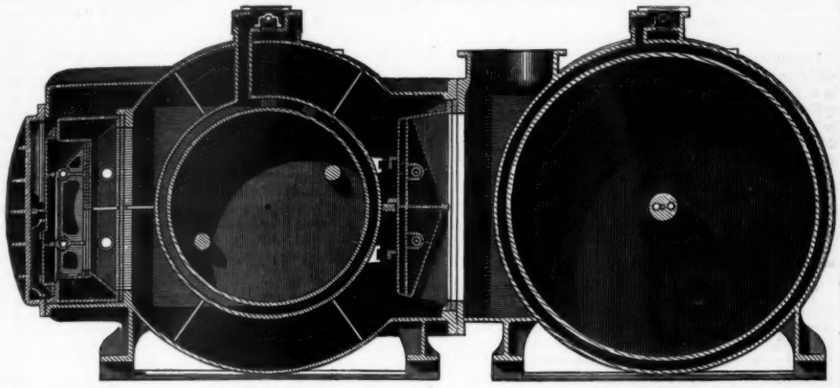
To enable the engines to be readily started, there is provided on the top of each cylinder an ordinary small slide valve moved by hand, by the aid of which the steam can be admitted and released from either end of either cylinder, the supply of steam thus admitted being drawn from the jackets, as shown by the section on the present page. The pressure of the steam thus admitted to the large cylinder is controlled by the ordinary escape valves, and by additional relieving valves opening to the intermediate receiver. These valves are required also to limit the compression in starting, before a vacuum is formed in the cylinder.

The condenser is situated on the opposite side of the crank shaft to the cylinders, and above the air and circulating pumps, the latter being worked by rods from the main pistons, while arms extending from one of the piston rods of each cylinder serve to work the bilge and feed pumps. The circulating pump is arranged to draw the water through the condenser, the water traversing the tubes of the latter while the steam circulates around them. The condenser exposes 5000 square feet of surface, and it can, if required, be used with injection, the circulating pump being in such a case rendered available as an additional air pump. The condenser tubes are divided into three groups, through which the water passes successively.

The engines are supplied with steam by six boilers, arranged as shown in the longitudinal and transverse sections of the stokehole on the present page. These boilers are cylindrical, and of the ordinary return tube class, each

ENGINES OF H.M.S. "TENEDOS;" SECTION THROUGH CYLINDERS.

CONSTRUCTED BY MESSRS. JOHN ELDER AND CO., ENGINEERS, GLASGOW.



boiler being 8 ft. 6 in. long by 10 ft. in diameter, and containing two furnaces 3 ft. in diameter. The total heating surface exposed is 5784 square feet, and the maximum working pressure is 60 lb. per square inch. The chimney is telescopic, and in addition to the air space surrounding it being used for ventilating purposes, there is a ventilating shaft about 21 in. in. diameter, carried up for a distance of about 18 ft. 6 in. within the chimney itself, this shaft being fitted with a damper at its lower end, as shown by the longitudinal section through the stokehole.

The total weight of the engines and boilers with water in the latter and the surface condensers, and with pipes, casings, &c., and the regular Admiralty allowance of spare gear is but 339 tons.

We recorded recently the very successful performance of the Tenedos during the official trials, but for convenience of reference it may be as well that we should repeat the particulars here. We therefore subjoin them, premising that the Tenedos is a wooden-built screw corvette of 1275 tons burthen.

PARTICULARS.	Six hours' trial at eight-knot speed.	Six hours' trial at ten-knot speed.	Six hours' trial at full power; mean speed 13.01 knots.
Draught of vessel, forward	13 ft. 4 in.	13 ft. 4 in.	13 ft. 4 in.
Draught of vessel, aft	16 ft. 4 in.	16 ft. 4 in.	16 ft. 4 in.
Draught of vessel, mean	14 ft. 10 in.	14 ft. 10 in.	14 ft. 10 in.
Displacement ...	1670 tons	1670 tons	1670 tons
Mean speed of engines in revolutions per minute ...	60.31 rev.	75.2 rev.	99.7 rev.
Rates of expansion	9 times	9.5 times	6.5 times
Mean effective pressure in small cyl.	...	...	25.2 lb.
Mean effective pressure in large cyl.	...	...	11.28 lb.
Consumption of coal per hour ...	700 lb.	1166.4 lb.	4681 lb.
Consumption of coal per I.HP. per hr.	1.58 lb.	1.35 lb.	2.32 lb.
Mean I.HP. ...	443 I.HP.	867 I.HP.	2018 I.HP.
State of weather ...	fine	fine	fine
State of sea ...	smooth	smooth	moderate
Barometer	29.98 in.	30.04 in.	29.92 in.
Thermometer ...	56°	56°	54°

We should notice that in all three trials all the boilers were at work, and thus at the lower power the losses by radiation and similar causes had a much higher proportionate effect than during the full power run; in fact, in the lowest power run, they more than counterbalanced the increased economy due to the expansion. During the 8-knot run, the throttle valve was nearly shut, and during the 10-knot trial it was also partly closed; hence, during the 8-knot run the initial pressure in the cylinder was much below the boiler pressure, and the number of expansions small. During the latter part of the full power trial the steam blower had to be used, and this caused an increase in the consumption of fuel. It is to be borne in mind, however, that Admiralty engines are not supposed to be at all times capable of exerting full power without the aid of the steam blast, as it is only under exceptional circumstances that full power is resorted to, and in such cases the consumption of fuel becomes a secondary object. Altogether, the engines of the Tenedos are thoroughly good examples of modern marine engineering, and we hope to see many such engines supplied to our navy.

OMNIBUSES IN PARIS.—In the week ending June 24, the Paris Omnibus Company had 503 omnibuses at work and the receipts were 12,804*l.* In the week ending July 15, the number of omnibuses at work was 507, and the receipts were 13,618*l.*, so that the company's undertaking would appear to be gradually reviving. The revenue of the company to July 15 this year presented, however, a decrease of 209,648*l.*, as compared with the corresponding period of 1870.

THE GEOLOGICAL FEATURES OF CLEVELAND.*

THE author stated that during the last twenty years, the Cleveland Hills have risen into national importance, as a mining centre, and from them is raised ore sufficient to produce one-third of the manufactured iron in Great Britain. Previous to 1850, it was known that ironstone existed, but it was not considered valuable enough for working, till the supply of ironstone from the coal measures of Durham had failed. He mentioned that the late Mr. Vaughan discovered the "main seam" of Cleveland in the face of the Eston Hills, and soon afterwards the erection of blast furnaces on the banks of the Tees was commenced. From that time to this the industrial activity of the district has gone on increasing steadily. After defining the part included in Cleveland, the writer said that the lowest geological formation is the new red sandstone, and that the course of the Tees from near Darlington to the sea lies through the Triassic series. There is a line of fault between Middlesbrough and Seaton. It has been proved that the Keuper Marls of North Yorkshire contain deposits of salt rock. Messrs. Bolckow, Vaughan, and Co. had come upon a mass upwards of 100 ft. thick, when boring for water at their Middlesbrough Works. It was thought that this could be pumped up in the form of brine, but as this did not succeed, a couple of shafts are now being sunk. The top beds of the Keuper, near Lackenby and Estón Stations, contain gypsum, which is being extracted for commercial purposes. A good deal of iron is found in the Triassic series. Irregular bands occur at intervals. Nodular masses are also found, and the whole formation is tinged a more or less deep shade of brown from the oxide of iron dispersed through it. It is in the top portion of this series that the main seam of Cleveland ironstone is situated, and from which the bulk of the stone now being smelted in this district is derived. Mineralogically, the stone is an impure carbonate of protoxide of iron, containing from 27 to 33 per cent. of metallic iron. This seam crops out along the northern slope of the Eston Hills. It there attains its maximum development, being in places nearly 14 ft. in thickness, and containing from 32 to 33 per cent. of iron. Proceeding eastwards at Upleatham, the stone is found cropping out also, and there it is from 11 to 12 ft. in thickness. At Hob Hill, near Saltburn, there is a small patch of ironstone. The ironstone bed may be traced along the coast in various places, but beyond Skinningrove it begins to split up, and the percentage of iron is not so high. South-west of Guisbrough the seam is much thinner, and at present the mines at Hutton Low Cross and Cod Hill are not worked. At Belmont and other places, south and east of Guisbrough, the stone improves in thickness and quality, and is extensively worked. The principal mines in Cleveland are situated in the Eston Hills (which, with Ormesby and Normanby, cover an area of from three to four square miles), and in a tract of country extending about six miles south-east from Upleatham and Guisbrough, and having an average breadth of about four miles. Over this area the ironstone has been for the most part proved, and large royalties are being opened out along the southern margin of the district under notice. The best stone of Cleveland is now known to cover from 27 to 30 square miles, and at the present rate of extraction, it is calculated that there is in this area alone sufficient store to last the whole of the existing blast furnaces nearly 100 years to smelt. Several analyses of ores were given, in which it was shown that the Eston stone is the richest, containing 33.62 per cent. of metallic iron, whilst the Upleatham had 31.97, and the Normanby, 31.42 per cent. It is an undoubted fact that there are many square miles of ironstone lying beyond the present active mining field, which will eventually come into the market, but not to any large extent until the portions nearest the coalfield are exhausted. Near the top of the Upper Lias another seam of ironstone, called the "Top Seam" of Cleveland exists. This is a very variable seam, both in extent and richness, being in some parts extremely thin, and in others it opens out into large dimensions. In Cleveland proper it is not worked, but further south it is being developed. The character of the stone, too, is not uniform. It is for the most part an impure oxide of iron, and yields in some places 40 per cent. of metallic iron. At Rosedale and Glaisdale, both beyond the limits of Cleveland, it is being largely extracted. At the former place, underlying the top seam, a large deposit of magnetic ore are found, but these are being rapidly exhausted. The deposit appears to be of a purely local character. There are not many faults to be found in the ironstone measures, though the undulations of strata cause the main seam to be found at very different levels. The main seam attains its maximum development towards the north, where also it yields the highest percentage of iron. Passing towards the south, there is a gradual thinning out of the seam, until at length shale partings come in, splitting up the ironstone into thin bands, of which not more than two are workable. The percentage of metallic iron also gradually falls until the stone becomes too lean to admit of its being used for smelting purposes. Indeed, it may be asserted broadly that at the present time a stone containing 24 per cent. of metallic iron may be regarded as of no practical value, and that each unit of metallic iron above this point has a value of about 6d. per ton. The higher members of the oolitic series contain a number of unimportant seams of ironstone, though in the neighbourhood of Castle Howard, somewhat extensive deposits of iron ore exist, but they are not sufficiently uniform in quality, or rich in metallic iron, to render them available for smelting purposes on a large scale. It would seem that the lias and oolitic strata of North Yorkshire contain immense quantities of iron ore, in the form of impure oxides or carbonates. The richest tract, however, is in North Cleveland, where an ironstone averaging from 30 to 31 per cent. of metallic iron is now being raised—to the extent of from five to six millions of tons per annum, and can be sold, after allowing a fair margin for profit, at from 3s. 6d. to 4s. per ton at the mines. The mines in this part of the district are within a few miles of the principal smelting works, and are also comparatively near to the Durham coalfield. It is impossible, therefore, for many of the thinner beds of ironstone further south to be brought into successful competition with the North Cleveland mines, and large quantities of really valuable ironstone will have to remain unworked until the richer districts become partly exhausted. Where the ironstone crops out along the escarpments of the Lias Hills, it is worked by means of day levels, but in other cases, shafts have to be sunk in the ordinary manner; but these do not as a rule exceed 100 fathoms in depth, whilst some are very shallow. The stone is worked upon the board and pillar system. After describing this method, the author stated that the cost of haulage is very trifling, and that the ventilation of the mines does not present much difficulty, as no explosive gases are met with, and the excavations are mostly very lofty and extensive, so that a good current of air can be readily made to pass through. At the Liverton mines, east of Saltburn, a combustible gas has been met with, which is now being utilised for illuminating purposes. The stone is there impregnated with bituminous matter. The author remarked that it has been proved that in Cleveland proper no coal measures at a workable distance from the surface exist. He then gave a short description of the Durham coalfield, from which at the present time so great a part of the coal and coke used in the smelting of iron in the district, is obtained. He stated that the south-western portion of the field yields several excellent seams of coal which are well suited for the production of coke of the best quality. The hardness of this material makes it adapted to bear a heavy burden in the blast furnace. The limestone used in the furnaces is obtained from Stanhope, Merrybent, and Forcett. Some had been got from the neighbourhood of Pickering, near York, and magnesian limestone from near Ferry Hill. The Cleveland district, the author showed, presents features not usually met with in iron-making localities. The greater portion of the blast furnaces are situated near to Middlesbrough and Stockton, on each side of the Tees. They stand upon a geological formation that does not yield any of the minerals used in the blast furnaces. The ironstone is brought a distance of from 3 to 20 miles; the coal and coke are obtained from the South Durham coalfield, and the limestone is brought distances varying from 20 to 40 miles. It is found, however, more convenient and economical to fix the works near to the river, as this affords greater facilities for getting away the manufactured article.

* Abstract of a paper read by Mr. John Jones, at the meeting of the Institution of Mechanical Engineers at Middlesbrough.

STEAM ENGINE GOVERNORS.

*On a simple construction of Steam Engine Governor, having a close approximation to perfect action.**

By Mr. JEREMIAH HEAD.

IN this paper the governor, as originally invented by James Watt, was first described, and shown to be to a certain extent imperfect in its action, but such imperfection has been increased by would-be improvers on Watt's invention, owing to a want of thorough comprehension of the laws regulating conical pendulums. These laws were next fully explained, and a modified governor was described nearly approaching perfect action. These governors are attached to all the engines at Messrs. Fox, Head, and Co.'s works, and answer their purpose perfectly. A highly-finished model was exhibited, showing the three distinct types of governors, namely, Watt's original governor, a common type of modern governor, with the arms hung from two distinct joints, and which is the worst type of all, and the approximate parabolic governor, which is almost perfect. The model showed very clearly the great relative superiority of the latter.

PROGRESS OF CHICAGO.—We are once more treated with some statistics illustrating the marvellous progress of Chicago. In 1830, the population, all told, amounted to only 70 souls. In 1850, it had risen to 29,963; and in 1870, it stood at 305,756. In 1840, the real and personal property of the city was estimated at 393,487 dols.; in 1871, it had risen to the great sum of 320,000,000 dols. What will be the greatness of Chicago in 1900?

* Abstract of a paper read before the Institution of Mechanical Engineers at Middlesbrough.

NOTES FROM PARIS.

PARIS, July 24, 1871.

TRADE PROSPECTS.

FAVOURABLE symptoms continue to manifest themselves on all sides: the abundance of capital shows itself in all forms; the Bank of France has reduced the rate of discount from 6 to 5 per cent., and its last balance sheet announces the increase of cash in hand, and the diminution in the circulation of bills.

IMPORTS.

The finance commission has taken into consideration an amendment which puts in question all that part of the project of the Government concerning the taxes on raw materials. By the terms of this amendment the proposed duty of 20 per cent. on first products, will be replaced by a tax on the consumption of manufactured articles. The commission hope, by this modification, to avoid all international difficulties, since the Anglo-French treaty of commerce, stipulates on behalf of the French Government, that when a national product is saddled with a duty on consumption, an equivalent tax shall be laid on similar imported articles.

TRANSPORT.

The want of means of transport continues to weigh heavy on agriculture, commerce, and industries. The Minister of Marine, has decided upon the motion of the Minister of Public Works, that to further public interests the State shall come forward to the aid of the railways, and assist as far as possible, with coasting vessels, the transport of the enormous quantities of goods accumulated in the south and centre of France.

THE SUEZ CANAL.

The general meeting of the Suez Canal Company was held in Paris on the 24th of this month. The counsel proposes a loan of 20,000,000 of francs. The canal at the present time is excavated to a depth of 26 ft. 8 in. along its whole length; the radius of the curves has been increased; in a word the canal is in a condition for the large development of traffic, but this does not increase so quickly as was hoped; it is necessary to wait the conversion of sailing ships into steamships, or at all events, into ships with an auxiliary steam power, before the enterprise will show the hoped for returns. In the first five months of 1871 the net receipts have risen to more than 3,000,000 francs against 2,231,000 for the same period in 1870, and the number of vessels that have crossed the canal has been 318 against 232. It is said that there was considerable agitation at the shareholders' meeting; the conclusion of the deliberation is adjourned for a month.

COAL MINES.

The French coal mines are in full work, the stock on hand is small, and prices continue firm. The journal of market prices, suspended by the war, is again on sale; the supply of metal also each day increases, but business can only be re-established with the re-establishment of the railways. One sees, indeed, a little slackness in business, which was so marked the previous week, and which must be attributed to want of rolling stock.

You have seen how the ministry, to check the speculators introducing into France enormous quantities of merchandise threatened with new import duties, has obtained from the National Assembly the rapid vote of a first law attacking sugar, coffee, wine, alcohol, tobacco, oil, and petroleum. The other duties increased, and imposts renewed, are naturally the object of the most anxious anticipations on the part of manufacturers and merchants. It is to be hoped that moderation will attend the first projects. The duty of 20 per cent. on raw material is the most reasonable. Already a large number of articles of consumption have increased their price, in view of the taxes which will eventually attack them.

The uncertainty which reigns also about the modifications which the legislation for collecting taxes will have to undergo, hamper also the progress of affairs. But again I may report that the inefficiency of railway transport is the great difficulty. It is reckoned that of the 120,000 wagons making up the total rolling stock on French railways, that about 14,000 have been destroyed, and 16,000 have been turned from their proper business by the exigencies which have followed the war. Thus, then, a quarter of the available material is wanting, just at a season when the cessation of the long stagnation tends to exceptional activity.

SUGAR MANUFACTURE.

The manufacturers of sugar in France have held a general meeting at St. Quentin, to discuss the question of the method of applying the duties on sugar. The increase of the tax was not discussed, only the method of its assessment. The more the tax is raised the greater the necessity for equitable distribution. The duty is applied to three classes of raw sugar. In the exportation of refined sugar, for the remission of the duty the conversion of raw sugar into refined sugar is valued, and for this valuation the sugars are divided into five classes, each of which is subject to special consideration. It appears that the French refiners find in this difference of classification of raw sugars for the valuation and for the imposition of duties, the means of obtaining great quantities of sugar free of all duty. The English refiners complain that their situation affects greatly the subvention of 1864, which had for its object the equalisation of trade facilities. The remedies proposed by the committee for the consideration of the administration are duties on consumption, that is to say, after the sugar leaves the refinery, or a duty on the rich saccharine matter as determined by analysis. They think that either mode of proceeding will suppress all favour, or unfair chance of profit to the refiner or to the manufacturer, and will give to countries with which France has large relations all guarantee of fair dealing.

BEETROOT SUGAR.

Inventors continue to work at various systems for utilising the beetroot pulp. M. Eug. Lebée has in operation in a factory at St. Quentin, a press on his system. The cylinders of this apparatus are composed each of 19 longitudinal segments each composed by the juxtaposition of about 600 thin plates of brass, leaving between them openings of about .003 of an inch, and united together on the interior. The juice flows into the cylinders through these small interstices which will not pass any fragments of the pulp. In case of accidents caused by the introduction into the cylinder of any foreign body, the repair is easily and quickly made since every facility is given to replace the segments.

WATER POWER.

The industrial society at Mulhouse has recently received communications about a project for utilising the fall of the Rhone at Bellegrande. According to the calculations of M. Daniel Calladon, of Geneva, this fall, which amounts to 13 metres could be utilised in such a manner as to produce 10,000 horse power. An American company employed in the production of phosphate of lime, proposes to construct a tunnel for utilising this fall, and offers to Alsacien manufacturers to construct at Bellegrande establishments similar to those they possess at present.

THE SOCIETY OF CIVIL ENGINEERS.

The Society of Civil Engineers has recently nominated the new members of its bureau and of its committee. It received on this occasion a farewell address from M. Vuillemin the departing President, and an inaugural speech from M. Yvon-Villarceau the new President. M. Vuillemin particularly recalled the active part which the civil engineers had taken in the defence of the country, and especially in the resistance of Paris: he enumerated the various services which had been rendered by them; he dwelt upon the patriotism and the disinterestedness that they had shown, and mentioned that their services had been entirely gratuitous. In spite of all the difficult circumstances, the work executed by the commission of the civil engineers left nothing to be desired both as regards good execution and moderate price. He hoped that the Government would carefully guard the remembrance of the aid that had been tendered by this body, and would restore in the future a great part of that industry, now removed in the manufacture of arms and appliances of war.

M. Yvon-Villarceau, who is a savant rather than an engineer, saw, in the election with which he has been honoured, a homage paid to theory. He wished to pay some tribute to those engineers who had known how to practise and to develop their profession, who had been always ready in the hour of danger, who wish to continue in the service of their country, and to contribute to her prosperity. Without doubt the engineer ought to contribute to the construction of the implements of war, and of military works, but they ought no less to hold themselves to the task of carrying out public works. They have, in general, administrative capacities which they are able to utilise to the profit of the country.

The distribution of food during the siege of Paris would not have been performed, with the glaring blunders all were acquainted with, had it been intrusted to the care of those whose training and whose business had taught them how to organise. Lastly, engineers know, from intercourse with workmen, the difficult elements of the social question, which, to be ill understood by the State, is a constant menace to society. M. Yvon-Villarceau also called the attention of civil engineers to two branches which ought to be connected intimately with their profession—the construction of philosophical apparatus necessary to the study of the sciences, and the execution of great geodetical operations, which involve the use of trignometrical surveying, and the determination of the true figure of the earth.

ANNUAL RAILWAY COMPANIES' MEETINGS.

The companies of the various railways are holding their general annual meetings, and the administrators are giving to the shareholders the statements of losses suffered by the war, and the diminution of traffic receipts. Dividends are, of course, fixed far below their usual figure, and the price of stock exhibits a marked fall. The Western Railway Company estimates at 10,000,000 of francs the cost of necessary repairs; the traffic of 1870, which was increasing during the past year almost up to the close of September, decreased greatly during the four following months, and gave a total of receipts of 76,179,000 francs against 84,259,000 for 1869.

WORKING RAILWAY INCLINES.

*Description of the Brake Drums, and the Mode of Working them at the Ingleby Incline on the Rosedale Branch of the North-Eastern Railway.** By Mr. JOHN HASWELL.

THE Ingleby incline is used for the conveyance of ironstone from the mines near Rosedale Abbey, being a portion of the line. It is nearly a mile in length with a gradient of 1 in 5¼, the steepest being 1 in 5. Loaded trains descend the incline, drawing up at the same time the empty trains, a passing place for the two trains being made in the middle of the length of the incline, by a short double line, and the rest is only laid with three rails, the centre one being common to both up and down trains. The incline is worked in the usual manner of steep mineral inclines by means of a pair of brake drums keyed upon a horizontal shaft, and situated at the top of the incline. The descending train of loaded wagons pulls off the rope from one of the drums and winds up that on the other, thereby drawing the return train of empty wagons up the incline. Speed is controlled by powerful brakes upon the drums, controlled by a hand winch. The peculiarity of the brakes is the use of cast iron. The drum barrels are 18 ft. diameter, and 4 ft. 3 in. long, made of cast iron 1¼ in. thick, and put together in four segments, which are bolted together. Chipping pieces are cast into the face of the flanges, and the segments are fitted so as to form the circumference of the winding barrel with complete accuracy. The wrought-iron brake straps extend round each side of the drum. They are lined with cast-iron brake blocks, and are bored out to fit the corresponding turned blocks on the rim of the drum. The two brake drums weigh together 68 tons, and the shaft, carriages, and brake segments about 26 tons. The ropes are made of steel wire, each 1650 yards long and 5 in. in circumference, weighing 8 tons. The rope end is taken through a hole in the side of the drum barrel, and wound two or three times round the shaft, and secured by a loop knot. A tail chain 12 yards long is attached to the other end, with riding chain 2 ft. long, for the purpose of disconnecting the rope and tail chain when the rope is tight. At the top of the incline are a series of pairs of inclined lateral chocks, fixed at intervals between the centre of the rails of the loaded wagon line; these chocks are pressed outwards against the wheels of the wagons, to check the speed of the loaded wagons until the drum rope is attached to them. The average loaded train weighs 52 tons, and the upload does not exceed 25 tons. Each run on the incline occupies three minutes, so that the speed of the train is 20 miles an hour. In ordinary working 200 wagons are run down per day of twelve hours, conveying 1600 tons of ironstone. These brake drums have now been at work about ten months, and superseded two smaller drums of 14 ft. diameter, which have been working about ten years. The smaller drums were fitted with brakes of wrought iron and elm wood. These required renewal every five weeks, at a cost of 20*l.*, and thus a saving of 200*l.* per annum is effected by introduction of the cast-iron surface to the drum and brake.

Mr. Haswell then mentioned several improvements which had been found necessary, and effected in the working of the brake. After being at work three months the wearing part was scarcely perceptible, although it worked twelve hours per day, and a train passed over the incline every five minutes. This method of using cast iron was an experiment. The saving effected by substitution of cast iron was equal to 200*l.* per annum. It was also found that the large drums could be stopped more easily than the smaller ones. No lubricator was used; simply a cast-iron journal.

The chairman, as a practical m..., was somewhat surprised by what he had heard, as to the brake dropper working dry upon the drums. He would like to hear the opinion of members upon the point, whether the experiment had been tried elsewhere, and the results.

Mr. Haswell explained that the use of dry cast iron did not originate with this brake. It was first introduced by Mr. Thompson, engineer upon the Pontop and Jarrow Railway, in the colliery district. They first tried it upon the small brake as an experiment, and then applied it to the other, where it was found to work perfectly satisfactory. After the brake had been freely used, the heating was only small; in fact, the finger could be laid upon it without feeling any great heat.

Mr. Lee inquired how long it had been in operation at one time. If he understood rightly, the paper said that the brake did not wear; he should have thought it would.

Mr. Haswell replied that the train ran at the rate of twenty miles per hour for three minutes, and then rested two minutes.

Mr. W. Cochrane said he had found cast and wrought iron to wear very much, but in this case it seemed to be cast iron working against cast iron.

Mr. Siemens stated that if this was the result of the experiment, it opposed all their preconceived notions of force and heat. They understood that a diminution of force was developed in the shape of heat in the brake; therefore it followed that if this brake did not heat, there must be very little force to be absorbed in the brake, and the levels such as absorbed a large amount of force. Perhaps Mr. Haswell could give them a little more information, whether the brake did not absorb a certain amount of heat. He could understand that two similar metals, like cast iron, might lubricate themselves to a certain extent.

Another member thought the alteration due to an increased friction surface, and asked Mr. Haswell to state the relative area.

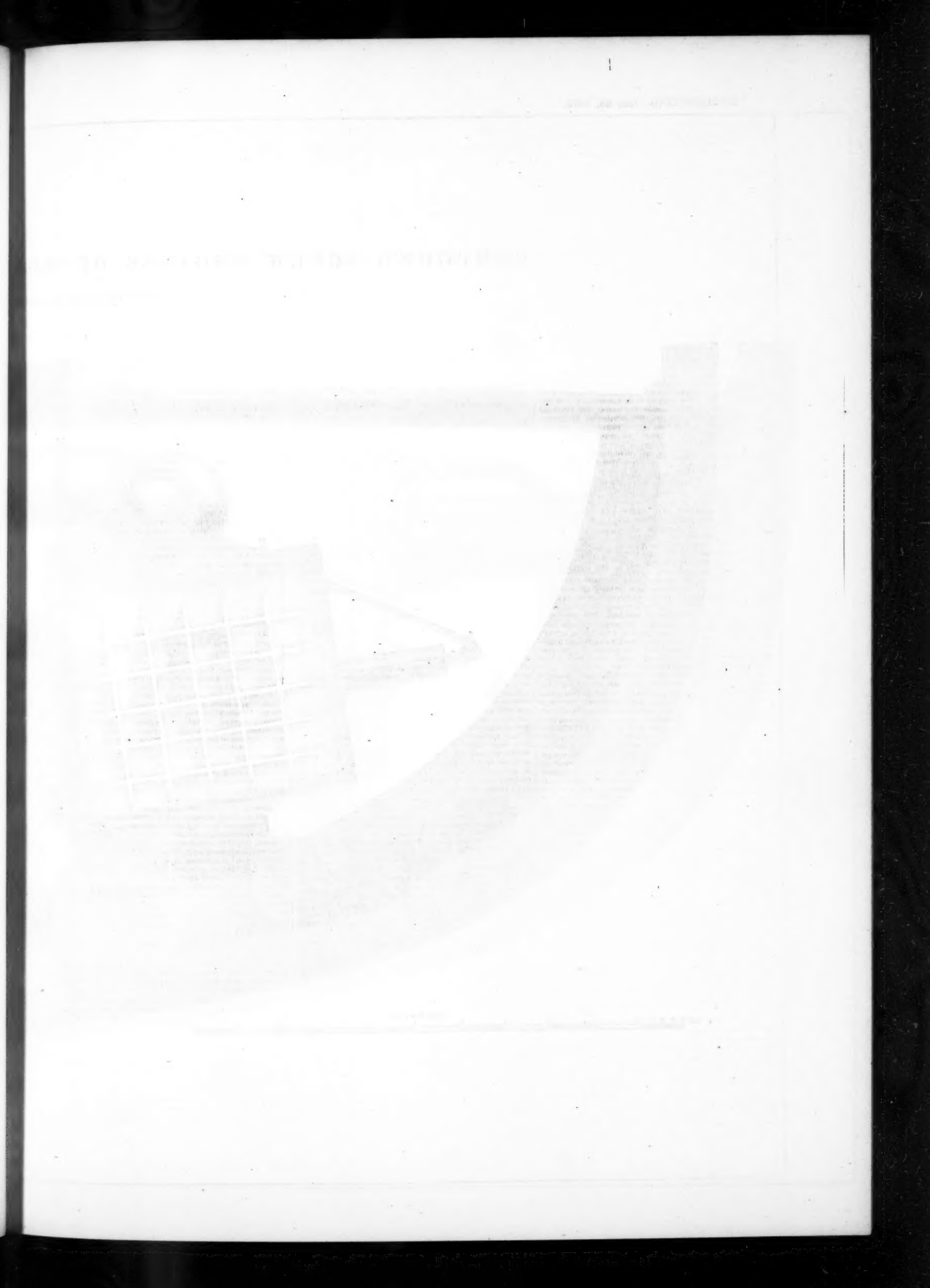
Mr. Haswell explained that the cast iron did absorb a large quantity of heat, and as near as he could calculate, there was about 30 ft. more surface upon the larger than on the smaller drum.

The chairman considered the discussion went to show that the dynamic theory of heat remained intact. It was quite clear that the cast-iron strap went a long way towards carrying off a large amount of the heat, and the proportion of increased surface would account for the rest. He proposed thanks to Mr. Haswell for the paper.

Mr. Gilkes mentioned that upon the Darlington section of the North-Eastern Railway, cast-iron brakes for wagons were introduced with complete success, being more economical, and of greater relative power.

IRON TELEGRAPH POLES.—Iron poles are being introduced upon the Prussian telegraph lines. In Switzerland also they have been tried with satisfactory results, and are expected to be largely used in future in the United States.

* Abstract of paper read before the Institution of Mechanical Engineers at Middlesbrough.



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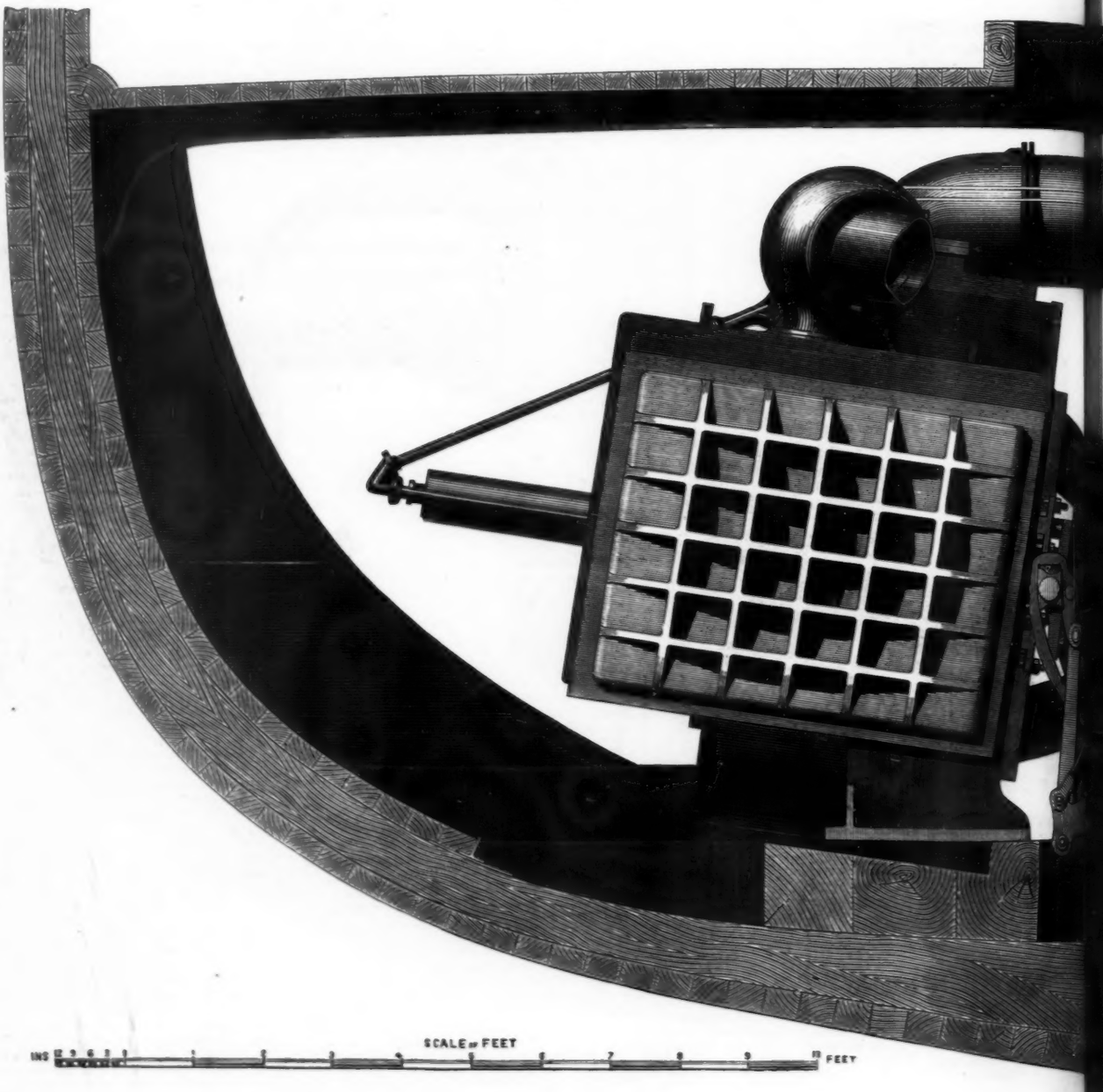

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MESSRS. DER AND CO., ENGINEERS, GLASGOW.

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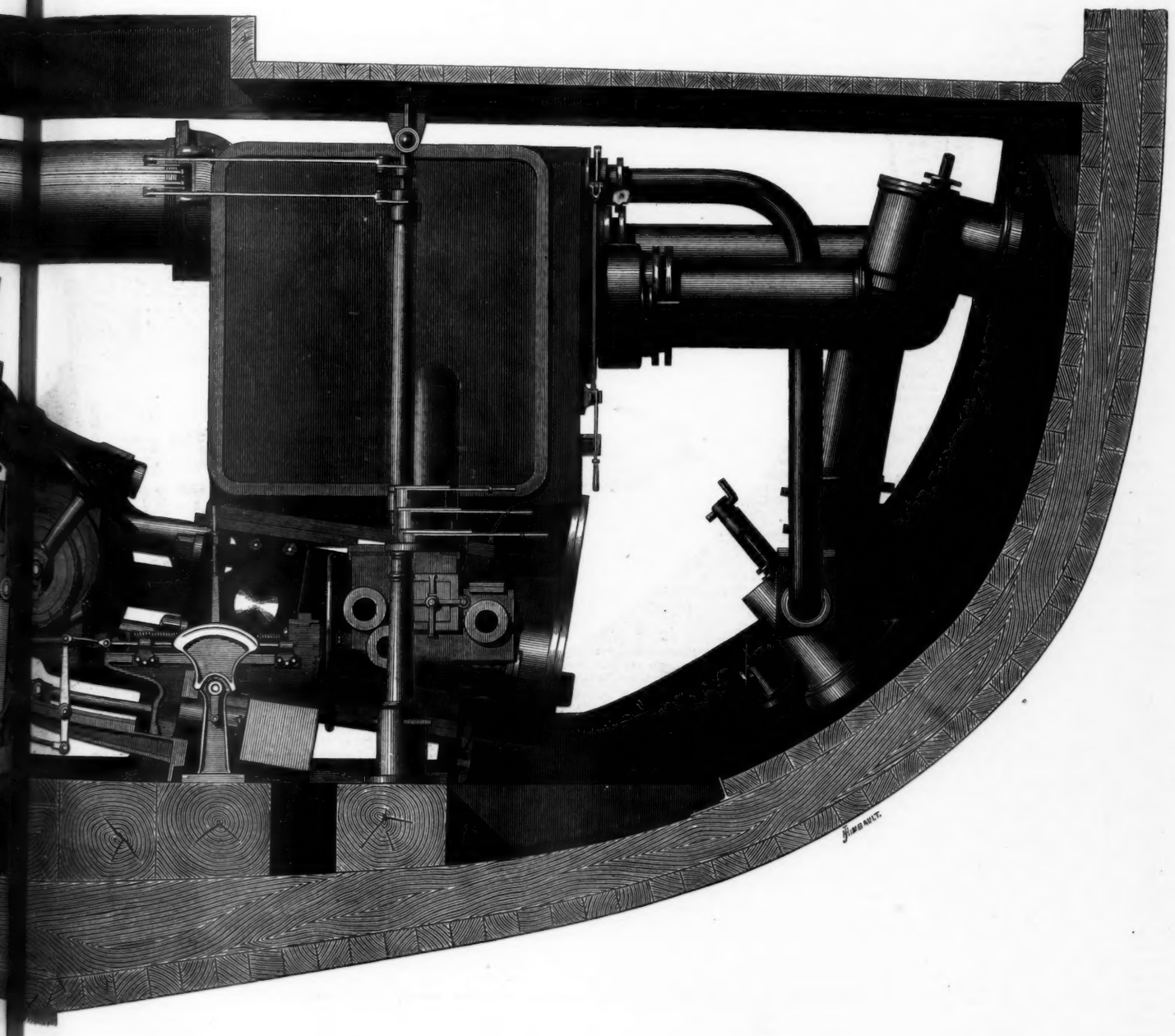

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CONTENTS.

	PAGE
Bauschinger's Indicator Experiments on Locomotives	51
The Art of Turning	51
Private Bills in Parliament	54
Manufacture of Hematite Iron	54
Notes from the South-West	55
Notes from the North	55
Foreign and Colonial Notes	55
Engines of H.M.S. Tenedos	56
The Geological Features of Cleveland	57
Steam Engine Governors	57
Notes from Paris	58
Working Railway Inclines	58
Company Epidemics	59
Experiments at Shoeburyness	59
The Alexandra Palace	60
The Institution of Mechanical Engineers	61
Mechanical Refinements	61
Notes from Cleveland and the Northern Counties	63
The Harvey Torpedo	63
The 35-Ton Gun	63
Robinson's Band Saw	64
The "Annales Industrielles"	64
Tredgold's Elementary Principles of Carpentry	64
Cleveland Iron Making	64
Tramways	64
Fiskeu's Steam-Ploughing Tackle at the Wolverhampton Show	65
Roofing Tiles	65
Recent Patents	65
Peat Fuel	66
The Employment of Surveyors	66
Titanium and Iron	66
Forged Screws	66

ENGINEERING.

FRIDAY, JULY 28, 1871.

COMPANY EPIDEMICS.

SCARCELY had the suspense caused by the recent Continental struggle ceased, and the clouds of smoke and the smell of powder cleared away from Paris, before the spirit of speculation, checked by the unwonted events which for a while arrested energy, and turned the stream of commerce almost entirely into military channels, awoke with an energy and vitality surpassing all that we have seen for the past eight or ten years. The evidence of this unexpected change has been visible in almost every daily journal that is published in this metropolis for many weeks past, and it is probable that though it will be checked for a short time during the coming season of idleness, with the recommencement of earnest business in the winter, it will be continued until it has run its course, and died away. But like seed thrown into fertile ground it will die away, only to spring up again with a fruitful crop of consequences, good or evil, and which will assuredly affect favourably or unfavourably trade and progress for another ten years. Numerous as the limited liability companies are which have during the last two months been brought before the public, they are, we take it, but the advanced guard of the main body of speculations which will open their winter campaign when the holidays are over. The public are recovering from the panic of 1866, money is in abundance, promising nvestments close to home, or far afield are more plentiful than they have ever been before, and the old story will be repeated of rash confidences, of brilliant anticipations, disappointment, ruin, panic, and stagnation. Through this orbit the commercial world revolves in periods of about ten years with bright sunshine and twilight half the time, and through darkness during the remainder. It is too much to hope that the season just about commencing will prove exceptional to those gone before.

It is curious to note how, in the main, each of these periods is a reproduction of its predecessor; how the intense caution and senseless fear which succeeds every collapse, checks business, makes it impossible to promote profitable undertakings, and creates a general season of stagnation, until suddenly all past experiences, all past losses, are forgotten, and the public fall freely again into the same meshes, but attracted by novel inducements to become again victims to losses, and a prey to fear.

The last great flood of speculation, it will be remembered, was crowded with railways brought in by hundreds, all sound and floating and promising fair, together with a shoal of minor craft, each with hope at the tiller. Nine-tenths of these last were swamped when the great storm came, and stranded the large ships, and were heard of no more, while many imposing wrecks were left as warnings to the public to use more caution for the future in trusting to the limited liability tide that leads to misfortune.

The taste is altered now, and railways are hard to administer to the public, unless they are far away, and more than a thousand miles in length—indications that such will before long come into favour are not wanting—and inclination leans to tramways, and especially to mining ventures. The mineral riches which have lately been brought to light in the mountains near the Salt Lake, form an especial attraction just now in the English market. The favour with which they are received has afforded also a good opportunity for owners further west to advertise mines on terms so captivating, that a few months since they would have been regarded with the greatest suspicion had they been made public. Such enormous profits are guaranteed in return for such minute investments, that one naturally wonders if, in this sceptical age, there exists one believer in the profuse liberality of those western owners of El Dorado. Day by day fresh schemes are advertised, the share lists are duly and quickly closed, and for a time we are shut out from further glimpses of the golden region into which the faithful have been admitted. As we stated last week, the tramway epidemic has taken the place of the railway mania of eight years since, and just as surely as costly railways then were in vogue, and were built to the subsequent dismay and confusion of shareholders, so now the same story will be repeated with tramways. They will be made, costing much and earning comparatively little, wherever the projectors and the engineers think fit, and can obtain Government sanction at home or abroad. The American institution, so long rejected here, will now be naturalised upon a most costly scale, and nothing until the reaction sets in will stop its progress.

Together with the two specialities that mark the present company epidemic, are a host of miscellaneous projects, some of which are unmistakably good, others far more than doubtful. But good and bad apparently meet with an equally favourable reception.

We cannot but regard this condition of things as the commencement of a crisis which in due time will work much evil. It can hardly be otherwise, and until the public learn some judgment, and are taught to avoid the equally dangerous extremes of undue apprehension and of unlimited confidence, the same sequence of events will take place.

There is, however, consolation in the thought that in all the evils attendant upon the speculation fever, which is now gaining ground, there is a share of good. There is no scheme, however idle, or however unprofitable, that indirectly does not bring its advantages. Work is created and money is circulated; whilst few undertakings are so utterly devoid of merit that they do not confer real and substantial public benefits, even though shareholders realise nothing.

Generalising for a moment on the probable results of the present tendency to invest largely in the money ventures of Utah and the Western States, it is obvious that while some few of the projects will, if judiciously managed, realise large profits, all will contribute in their degree, towards breaking down the barriers which at present exist in the way of universal co-operation. No work can be developed without waste of power, and in this work money is the power that must be wasted. Helpless as all are to resist or largely to direct the force of the waves of speculation that break over us from time to time, there is at least a satisfaction in seeing that each one advances us nearer and nearer to the desired end.

EXPERIMENTS AT SHOEBURYNESS.

NOTWITHSTANDING the state of perfection to which our projectiles have been brought within the last few years, that perfection is at present only relative. Our manufacturers and others have therefore been endeavouring to render it absolute, and the War Office authorities have promoted, as far as they can, the discovery of the best metal for shot. In this interest mainly, our national experimental artillery ground at Shoeburyness was again the scene of some interesting trials, which were carried out on this day week. The objects were to test the value of some new 9-inch chilled shot, supplied by Mr. Unger, of the Fingspong Works, Sweden; to try some 9-inch steel shell supplied by Messrs. Firth, of Sheffield, and some 11-inch Palliser shell. To these was also added the trial of a new picric powder for shells, which is the invention of Professor Abel, of Woolwich. The experiments commenced with the Fingspong—or as they are playfully called at Shoeburyness, the "fish-pond"—shot, fired from the 9-inch muzzle-loading gun, with charges of 43 lb. of R.L.G. powder at 200 yards range. The gun was laid against the thin portion of the 48 ft. target, described by us last week in our article upon the previous series of experiments. This, it will be remembered, consists of an 8-inch plate, backed by 18 in. of teak, and a ¾ in. skin. The peculiarity of the Fingspong projectiles consists in their being made from a metal which is so soft that, although the head is cast in a chill, it can readily be turned afterwards. It would appear to be working out on a large scale the old experiment of shooting a candle through a deal board, for the theory of these projectiles is that they shall effect complete penetration without breaking up. This, we were informed by an impartial observer, they have done over and over again on the Continent; 10¼-inch and 9-inch shot having alike readily penetrated and passed through an 8-inch armour plate, coming out whole in the rear. This, however, they certainly did not do at Shoeburyness on Friday last.

The first round was fired with one of these solid chilled shot weighing 253 lb. It entered the target at an angle of 45° to the face of the plate, striking it 7 ft. 6 in. from the proper right end, and 15 in. from the bottom, being 5 ft. from the line of aim. The shot, which had missed both of the velocity screens, broke up, the head remaining in the hole. The rear of the target sustained little or no damage. The erratic course of this shot was attributed partially to the gun being cold, no scaling charge having been fired, and partially to the softness of the studs. Round No. 2 was therefore a repeat of No. 1, the projectile striking the target at a point 3 ft. 1 in. from the right proper end, and 5 in. from the top of the lower plate, being a deviation of 2 ft. 7 in. from the point aimed at. The shot effected total penetration, in which it was assisted by a previous shot hole, passing out in the rear through a smiths' shops—which was, of course, empty—and breaking up. The point and several large fragments were found on the tramway some 50 yards to the rear of the target. A 9-inch Firth's steel shell, weighing 241 lb., and filled with a bursting charge of 7¾ lb. of powder, was then fired from the same gun. The projectile this time cleared the target altogether, passing over the top, and burying itself in the earth roof of an old casemate several yards to the rear, without exploding. This result rendered it apparent that either the shot did not centre in the gun, or that the platform was unsteady, and that the deviations of the Fingspong projectiles were due more to defects in the piece or platform than to softness in the metal of the studs.

At this stage the proceedings were varied by Colonel Milward, who directed the trial of the picric powder to be made. This powder is of a bright yellow colour, and is prepared from carbolic acid. Mr. Abel places it, as regards explosive effect, half way between gunpowder and gun-cotton. He states that it does not act injuriously on the metal of a gun when fired from it, and although not at present fitted for that use, a modification may hereafter be found which will answer the purpose. The first round, No. 4, in the consecutive order, was with a 9-inch large core Palliser shot, having a bursting charge of 4 lb. of gunpowder, in order to afford a comparison with the picric powder. The gun charge was 43 lb. of R.L.G. powder as before, and the range 200 yards, the gun being laid against the thick portion of the target, which is composed of an 8-inch plate, 6 in. of teak, a 5-inch plate, 6 in. of teak, and a 1½ in. skin. The shot struck the lower plate 12 in. from the bottom and 4 ft. from the proper left end, effecting a penetration of 18.2 in. and bursting in the hole. The rear part of the shell was blown to the front, some of the fragments of the base flying back nearly to the gun. The next

round was fired under precisely similar conditions to the last, with the exception that the bursting charge of the shell was 4 lb. of picric powder. The results also were very similar, the shot striking the same plate 3 ft. 4 in. from the proper left, and 2 ft. 4 in. from the base. The head remained in the hole, effecting a total penetration of 17.5 in., the rear of the projectile and some of the picric powder being blown to the front. No conclusion could be arrived at from these two shots as to the relative values of picric powder and gunpowder, as the shots did not penetrate sufficiently far into the target for the charges to have any lateral effect upon the structure. It is probable that the charges were too sensitive, and burst a little too soon, thereby preventing further penetration of the shot. No doubt by retarding explosion, the projectile would have a better penetration and the burst would take place at the right moment with better effect. Be this as it may, we have at present no data whereon to base an estimate of the value of picric powder as a charge for shells.

The order of the programme was then resumed, and round No. 6 was a repeat of No. 3, rendered necessary by Firth's shell in the former round flying over the target. In the present case the shot grazed the ground 18 ft. from the face of the target, ricochetting on to the plate, there making an indent 15½ in. long by 9 in. wide, and 3 in. deep, and breaking up. This result rendered another repeat necessary, and the projectile in No. 7 round struck the upper plate of the thin part of the target 12 ft. 7 in. from the proper right end, and 2 ft. 8 in. from the bottom of the plate. The shell burst in the wood backing, the point of the head projecting several inches through the rear skin. Although a considerable amount of damage was done to the rear, it is certain that that damage would have been much greater had the explosion been slightly retarded. A return was them made to the Fingspong metal, a cored—or rather a bored—shot being directed against the thin portion of the target. It struck the upper plate 11 ft. 9 in. from the proper right end, near the upper edge of the plate, and 2 ft. 9 in. from the line of fire, entering at an upward angle of about 45°. A penetration of about 12 in. was effected, the point remaining intact, but rebounding, with a large portion of the body attached to it, 5 ft. to the front. The projectile—so much as remained of it in one piece—was much cracked longitudinally, and was afterwards broken up by about a dozen blows from a heavy sledge hammer. This round decided the fate of the Fingspong projectiles, which, although made of splendid metal, did not in these samples reach the standard of the chilled projectiles at present turned out at Woolwich. The ninth round was with a 9-inch Firth's steel shell, carrying a bursting charge of 7 lb. 6 oz. of powder in two bags. The shell struck the thin portion of the target 1 ft. 7 in. from the proper left of the upper plate, and 1 ft. 9 in. from the top, bursting in the wood backing, which it set on fire, and doing considerable damage to the rear portion of the structure. A heavy piece of the shell was thrown to the rear of the target, which bore witness to the great destructive effects of the projectile, the teak backing having a large hole blown upwards above the point of explosion, opening to the top of the works. In the last few rounds with the 9-inch gun, the shots were delivered well on to the points of aim, so that the gun appeared to have warmed to its work, although the earlier shots were much more wild than, under the circumstances, they ought to have been. The fouling of the gun probably aided in insuring the correctness of the later results.

The splendid 11-inch Woolwich gun was then brought into play with a Palliser shell filled with a bursting charge of 9 lb. of powder. The gun was laid to the thick portion of the target at 200 yards range, and was fired with a charge of 85 lb. of pebble powder. The projectile had a velocity of 1262 ft., and struck the lower plate 18 in. from the top edge, and 3 ft. 6 in. from the proper right end. It passed clean through, bursting splendidly in the wood backing, and yet the base plug and portions of the shell were driven through far to the rear. In the eleventh and final round, the gun charge was reduced to 75 lb. of pebble powder, and a Palliser cored shot charged with 6 lb. of powder. The velocity was 1187 ft., and the projectile struck the upper plate of the thick portion of the target 16.5 in. from the bottom edge, and 19 ft. from the proper left end of the plate. The shell went clean through the target, bursting apparently in its passage through the skin. The results were eminently satisfactory, and fully maintained the character of this excellent weapon and of the projectiles.

The results of the day's proceedings served to establish three things mainly. Firstly, the inferiority of the Fingspong projectiles to those turned out at Woolwich; secondly, the exceptionally fine character of the Firth steel shells; and thirdly, the subjection of the targets to the guns once more. There is one thing to be said for the 11-inch gun, and that is that it is properly mounted on an iron carriage and slide, which its 9-inch companion is not. This may in some measure account for the wild shooting of the latter at first. But, however this may be, it is to be hoped that steps may be taken to insure a proper mount for every experimental gun, so that fair and accurate results may be obtained. It is a curious fact that the 11-inch gun has been greatly decried in the past, no one appeared to have any confidence in it, notwithstanding that a number of Blakely guns of that calibre were made years since, and have done good service in Peru. But now that the 11-inch gun has asserted its position, it is very probable that a strong tide of military opinion will set in, in its favour.

THE ALEXANDRA PALACE.

SITUATED on the highest point of land in the centre of some of our finest suburban scenery, and commanding a wide range of pleasant prospect, stands the Alexandra Palace, the Phœnix of the Great Exhibition of 1862. That building will be memorable as the last great work with which the Prince Consort was actively connected, but which he never lived to see completed. Upon the demolition of the more temporary portion, the materials were transferred from South Kensington to Muswell-hill, where they were re-erected in a substantial and tasteful manner. The Muswell-hill estate had been purchased for that purpose, and for the formation of a park and public recreation grounds. The grounds are undulating, and upon the crowning point the palace was built, and it commands on all sides extensive and varied views of the surrounding country. The palace was erected in 1864, but owing to various circumstances into which it is unnecessary here to enter, it has never yet been consecrated to public use, nor rendered beneficial to enterprise, although eminently calculated to succeed in both respects. Now, however, a reaction has set in, a tontine association has been organised, the object of which is to complete the purchase of the estate, and improve the property, and to provide a grand institution of healthful recreation and elevating instruction for all classes. It is proposed to combine the solid advantages of the South Kensington Museum and Schools of Art with the lighter pleasures and pastimes of the Crystal Palace. In furtherance of these views a series of exhibitions, art unions, and distributions are proposed. The park is to be enlarged and laid out as pleasure grounds, with the exception of some land on the border which will be reserved for building purposes. The park surrounds the palace, and comprises about 400 acres within a ring fence.

The importance of such an institution to the public generally, and to the inhabitants of the northern and eastern portions of the metropolis in particular, cannot be over-estimated, and by it the interests of art and science cannot fail to be promoted. In these interests we recently paid a visit to the Alexandra Palace, and, seeing that the scheme we have shadowed forth is about to be endued with vitality, it will probably be interesting to our readers to learn the particulars of a building which has had but little attention paid to it for a long time past. The general plan of the palace consists of a nave, 900 ft. long and 85 ft. wide; a centre transept, 430 ft. long, and of the same width as the nave; and two shorter transepts, each 320 ft. long, and of the same width as the last. The centre of the building is covered by a dome, 170 ft. in diameter, and 220 ft. high in the interior. At the intersections of the shorter transept with the nave there are pendentive octagon cupolas, supported on slender columns, and lighted by windows in the sides. The ends of the nave and three transepts are terminated with large rose windows, decorated with stained glass. On each side of the nave and transept are buildings about 50 ft. wide, and two stories high, having brick external walls, with arcaded openings and windows, and forming extensive galleries next the nave and transept. The ground floor on the south side is arranged for refreshment and dining purposes, whilst in other parts there are to be a library, museums, picture-galleries, writing-rooms, &c. A grand organ, now nearly completed, forms the centre of an orchestra for musical performances on an extended scale. The interior is elegantly decorated throughout in coloured ornamentation, and will be filled with objects of beauty and interest, arranged in spaces so as not to interfere with the grand avenues for promenade. A number of articles for this purpose were purchased at the Paris Great Exhibition, and are on the premises awaiting arrangement.

Turning to the external portion of the building, we find the end of the nave and transepts presenting eight grand façades flanked by supporting turrets, containing the large windows and entrances. These façades are united by the walls of the lower buildings, two stories in height, and by the clerestory walls and roof of the nave and transepts. The whole is terminated by bold cornices and ornamental parapets. Above the roofs in the centre of the building rises a bold tambour pierced with windows, from which springs the great dome, terminated at the top by a simple balustraded parapet and a standard mast 50 ft. high. The dome as well as the octagon cupolas at the smaller intersections already referred to, are decorated with moulded ribs and panelling in bold relief. The general character of the architecture of the exterior is Italian, and consists principally of brickwork in colours with stone dressings and ornamentations. Surrounding the building on all sides are spacious terraces flanked by ornamental slopes. The terrace on the north-western side of the building will be 1000 ft. long and 160 ft. deep, carried on the Italian arcades. Under this terrace it is intended to form a railway station from which direct access will be had to the building at the ends of the three transepts. It is proposed ultimately to bring all the railways of London to this station.

Both the interior and exterior of the building are each marked by a special feature. That in the interior is the grand organ, which will be one of the most powerful and complete in England; whilst that on the exterior is the racecourse. The organ stands in the north transept, and is now in course of completion by Mr. Henry Willis, the builder of the instruments at the Albert Hall and St. George's Hall, Liverpool. It possesses five claviers, four for the hands and one for the feet. There are one hundred and one stops, eighty-seven of which are sounding stops. The instrument is governed by various mechanical arrangements for varying its powers and qualities of tone. Amongst others we may mention the pneumatic pistons for the hands, each clavier possessing six. There is also a complete system of combination pedals acting in a similar manner to those in the grand organs recently erected in the cathedral of Notre Dame and the church of St. Sulpice, Paris. The pedal organ contains four stops of 32 ft., three of which are open. The largest pipe in the front of the organ, and which is not yet in place, is 40 ft. high and 2 ft. in diameter. It is the metal representative of C C C C, and, with the exception of a pipe of similar dimensions at the Albert Hall, we believe it is the only metal pipe of that note near London. At present wind is supplied to the organ by a portable engine placed in the basement, and remote from the instrument itself. When complete, however, it is intended to blow it with two engines similar to those at the Albert Hall, and which we understand are now in course of construction.

The special feature by which the exterior and surroundings of the palace is marked is a racecourse and grand stand. The course is laid out on slightly undulating ground, and has been well drained and levelled throughout, the turf having been taken up and carefully relaid on a bed of ballast, to improve its elasticity. The grand stand is situated on the edge of the rising ground in front of the palace. The general character of the architecture of the exterior is Italian, with a bold frontage of steps from the lawn to within the whole length and breadth of the building. It comprises an entrance hall 40 ft. by 18 ft., adjoining which are two towers containing the stairs leading to the grand stand room and a lead flat. This room measures 130 ft. by 25 ft., and is divided into private boxes and steward's compartment. The remainder of the building and its adjuncts are arranged for refreshment rooms, jockeys' rooms, and the various necessary offices. Here, then, we have an admirably arranged property ready to hand, only awaiting the magic touch of capital and enterprise to endow it with life and activity. It is admirably adapted for the purposes in view to which we have referred, and the undertaking has our best wishes for its success.

MECHANICAL REFINEMENTS.

No. VIII.

TO THE EDITOR OF ENGINEERING.

SIR,—The engineer or machine builder who bolts all that it is possible of the different parts of his work together in the foundry, takes some risks and avoids many others. If in casting, any part is bad the whole is lost, and if during the construction of the machine or afterward, either by accident or weakness a part is broken, the whole structure may be lost, or unusual expense incurred to repair damages, still these risks are far more than counterbalanced by the advantages gained in "bolting the parts together in the sand." It not only costs money to make joints and bolts, drill, and tap holes, &c., but joints, however well made, are liable to get loose, and it is this getting loose of some part that causes more wear and breakdowns than any other one thing—or perhaps I might safely say

FIG. 1

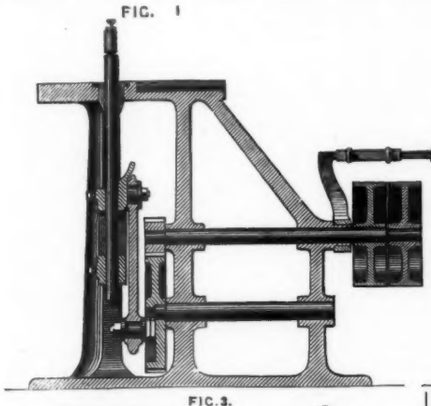


FIG. 2.

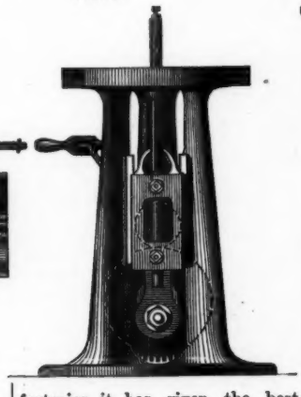
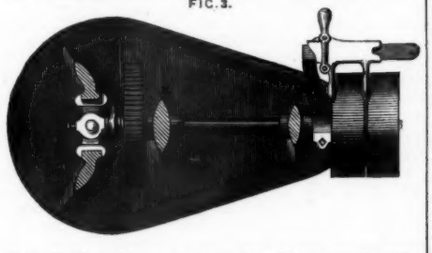


FIG. 4.

FIG. 3.



than all other things put together. [Constructing the work so that it may be conveniently repaired is not a very new, nor as yet an extinct theory in machine building, but is it the true one? Is it better to make a machine that can be conveniently repaired, with the chances that it will be constantly requiring it, than to make one that cannot be, with the chances in its favour that it will never need it? It is but a question parallel with another, whether boxes and slides that can be adjusted with the danger of their getting loose or being by the unskilled operator set too tight, is better than solid work liable to but one fate, that of wearing out. By faith in the latter of these comparative theories and an eye for simplicity in design, the builder of the key-seat cutting machine shown in Figs. 1, 2, 3, and 4, has been governed. While I have shown what appears to me a better way than keys for securing wheels, the extensive use of ratchets and clutches, particularly in harvesting machinery, would, even if screwing on wheels was universal, render some kind of a key or feather way cutting machine a desirable if not an indispensable tool.

It will be seen by referring to the drawings that the shaft carrying the tight and loose pulleys has at its other end a small pinion gearing into a wheel having a slot cast in it, within which the wrist pin is secured, forming an adjustable crank, the throw variable from 2 to 8 in.; a simple cast-iron connecting rod communicates motion to the crosshead or slides, which is simply a mechanical fit without gibs; the working mandril or tool holder is secured in the crosshead by two set screws, and may be adjusted vertically. The only invention claimed is the peculiar construction and method of operating the tool, clearly shown in Fig. 4, which represents the upper end of the mandril, the tool; A, is simply a square bar formed in the segment of a circle—a ring of the proper diameter turned in a lathe makes several. By screwing down the free-fitting screw cap, B, at each stroke of the machine, the tool is forced further and further out from the side of the mandril until arrested by the adjustable stop, C, which gauges the depth of the groove. The spiral spring forces back the tool when the cap is run back. Different sized mandrils are used for large and small work by changing the bush in the table and bushing the holes in the crosshead. The belt shifter, which is a self-locking one, is applied to the machine in a manner very convenient. The bracket upon which the fork slides is secured to the main frame by a "grip fit" clasping the end of the box, thus by loosening the grip screw the fork may be turned around the pulley to accommodate itself to the belt, regardless of the direction from which the power is derived. It will be seen that the machine is complete in itself, and that it would be difficult to dispense with a single piece. Where it has been used in large mowing machine manufactories it has given the best satisfaction.

Of all the methods or processes of working and finishing steel, probably there is none extensively used about which there is so little known by mechanics in general as that of the "friction wheel," and this lack of knowledge has no doubt kept its use confined within the bounds of almost a single class of work. It is generally known that the smooth edge of a soft steel, or iron wheel, when run at a high speed, will cut tempered steel, soft steel, iron, and other substances very rapidly, but with it goes the belief that steel so cut is practically ruined for all useful purposes. This is true only to a certain extent, and is entirely avoidable by a proper speed of the friction wheel and a skilful operator. A smooth steel wheel running with a periphery speed of from two to three miles per minute, will cut steel at a rapid rate and without heating it to such an extent as to even change the colour, the cutting wheel, too, retaining its form for a great length of time without being re-turned. Not only the spiral sides of augers and auger-bits are smoothed out and finished by friction wheels, but the fine screw points of the same are wholly formed by the sharp edge of a soft steel plate run at the frightful speed of 14,000 revolutions a minute. The freedom from heating or burning the work, as well as the accuracy and beauty with which it is done, is unquestionably in a great measure due to the skill of the operator; still this skill may be matched by the skill of inventors, and the friction wheel applied to hundreds of purposes yet unthought of.

I am, yours truly,
AN ENGLISH ENGINEER IN AMERICA.

THE INSTITUTION OF MECHANICAL ENGINEERS.

THE annual meeting of the Institution of Mechanical Engineers has been held, during the current week, at Middlesbrough, and no place, probably, could have been chosen affording greater facilities for the inspection by the members of works and objects of professional interest. Situated as it is in the heart of the Cleveland district, Middlesbrough not only itself contains numerous works, where the latest and best iron-making practice may be studied, but it is in the immediate neighbourhood of other places of almost equal importance, abounding with large engineering establishments, which have been most freely thrown open for examination, and which include a great variety of practice. When it is added to this, that a warm welcome has been accorded to the Institution by the engineers and ironmasters of the district, and that the local committee and its honorary secretaries, Mr. Jeremiah Head and Mr. Gilbert Gilkes, have done everything that could be done to promote the comfort of their visitors, it is not surprising that the meeting has been, so far, at least, a complete success.

The meeting commenced on Tuesday last, at the Odd Fellows' Hall, Middlesbrough, under the presidency of Mr. John Ramsbottom, and after some preliminary routine business had been disposed of, a paper was read "On the Manufacture of Hematite Iron," by Mr. William Crossley, of Askam-in-Furness. This paper, which possessed much practical value, we reproduce in abstract on another page, and we need, therefore, only remark here that it was followed by a brief discussion, in the course of which it was pointed out by Mr. I. Lowthian Bell that the arguments used in favour of the employment of furnaces of very large capacity for the reduction of Cleveland ore did not apply to furnaces employed for smelting hematite, and that probably the furnaces now in general use in the hematite district were probably of about the best size for the particular work they had to perform. Mr. Bell's views were generally agreed to by the other speakers, and the discussion was brought to a close without eliciting any facts of special interest. Next came a very able paper by Mr. I. Lowthian Bell, "On the Preliminary Treatment of the materials used in the manufacture of Pig Iron in the Cleveland District," and this paper, which we also publish in abstract in the present number, was followed by a brief discussion, in the course of which Mr. Charles Cochrane expressed his dissent from some of the conclusions arrived at by Mr. Bell concerning the practical inutility of reducing or partially reducing the ore before its entering the furnace, while Mr. Siemens informed the meeting that he was now erecting some coke ovens somewhat on the Appolt plan, but in which regenerators have been added to equalise the heat maintained throughout the process. After some remarks from Mr. Ord, Mr. Williams, Mr. Edwin Jones, and Mr. Marley, Mr. Bell replied to the discussion, and in so doing controverted Mr. Cochrane's views, and expressed his opinion that the defects of flue coke ovens were not such as were to be remedied by the addition of regenerators, and that, in fact, in the Appolt oven there was an abundant supply of gas, even towards the conclusion of the coking process, so that there was no difficulty in maintaining the heat.

The last paper on the list on Tuesday was a "Description of the improved compound-cylinder blowing engines at the Lackenby Iron Works, Middlesbrough," by Mr. Alfred C. Hill. The engines referred to in this paper were illustrated by us in our last number, and we propose, therefore, instead of publishing the paper itself, to abstract from it some particulars concerning the engines, additional to those which we have already given. The water at Lackenby being drawn from the gypsum strata, is very hard, and to avoid the inconvenience resulting from its employment in boilers, the new engines have, as we explained last week, been fitted with a surface condenser, while to promote economy, they are constructed on the compound system, and are to be worked with steam at 85 lb. pressure, supplied by Howard's boilers, heated by the gases from two blast furnaces. The steam cylinders are, as we have stated, respectively 32 in. and 60 in. in diameter, while the blowing cylinders are 80 in. in diameter, and the stroke is 4 ft. 6 in. The low-pressure cylinder is steam-jacketted, and the valves of both cylinders equilibrated on Dawea's plan, already described in our pages. The cranks, instead of being situated at right angles to each other, as is usual in coupled blowing engines, are placed directly opposite, so that the moving parts of the two engines balance each other, and the steam passes direct from each end of the high-pressure cylinder to the corresponding end of the low-pressure cylinder. Provision is also made for working either cylinder independently, the connecting pipes being fitted with valves for shutting off the communication between the cylinders, and relief valves being provided on the valve-chests of the large cylinder to prevent steam of an undue pressure from being admitted to the latter. When working the engines independently, it is proposed to throttle the steam admitted to the upper valve-chest, and

thus, by reducing the pressure of steam supplied to the upper end of the cylinder, approximately balance the moving parts.

The surface condenser contains 1080 tubes ¾ in. in diameter exposing 1087 square feet of surface. The condenser is also fitted with an injection pipe having a rose directly opposed to the mouth of the exhaust pipe, the injection pipe being intended to be ordinarily used for admitting the small quantity of water required to make up losses by leakage, &c. The air and circulating pumps which are worked by levers from the crosshead of the low-pressure engine as explained by us last week, are respectively 16 in. and 24 in. in diameter, the stroke being in both cases 2 ft. 3 in. The feed pumps, of which there are two, have 3½ in. plungers, also with a stroke of 27 in. The valves of the blowing cylinders are of leather and are arranged in the manner shown by our illustration last week, the aggregate area of the inlet valves for each end being 860 square inches, and that of the outlet valves 600 square inches. The clearance between the blowing pistons and the cylinder covers is but ¾ in. and the capacity of the total clearance space at each end but 5 cubic feet. The engines are, we understand, to supply blast at a pressure of from 4 to 4½ lb. per square inch. Unfortunately the engines although almost completed could not be got to work in time for the melting, and under these circumstances the discussion on Mr. Hill's paper was adjourned, the author promising to lay particulars of the performance of the engine before the members at a succeeding meeting.

Tuesday afternoon was devoted to visiting the various and numerous works at Middlesbrough, thrown open to inspection, and on Wednesday morning the reading of papers was resumed, the first being an interesting and timely communication "On the general Geological Features of the Cleveland Mining District," by Mr. John Jones. Of this very interesting paper we give an abstract on another page, and we need not, therefore, say more concerning it here. Next came a "Description of the brake drums and the mode of working at the Ingleby incline on the Rosedale branch of the North-Eastern Railway," by Mr. John A. Haswell, of Gateshead. This paper we also publish in abstract on another page, together with the discussion upon it. The leading feature in these brakes consists in the rubbing surfaces being of cast iron working on cast iron without any lubrication, and it appears to us that their success is to be attributed to the small pressure required per unit of rubbing surface, and to the short period during which the brakes are continuously in action. How small a pressure actually required on the brake surface really is was not pointed out either in the course of the paper or during the discussion, and it may, therefore, perhaps be as well that we should speak of it here. On referring to the paper it will be seen that the difference in weight of the usual ascending and descending loads is 27 tons, and when the loaded train is on the steepest part of the incline, namely 1 in 5, (the unloaded train being on a flatter gradient) the retarding force required will probably be about 5½ tons. The brake drums with their attachments, however, weigh 94 tons, and to keep this mass in motion and overcome friction a pull of about half a ton would be required at the circumference of the drum, while a further resistance of about the same amount may be taken as due to the aggregate train resistances. The total amount of retarding force to be exercised by the breaks is thus reduced to 4½ tons, and if we take the coefficient of friction between the drums and straps as $\frac{1}{14}$ of the pressure we shall have the pressure required at $4\frac{1}{2} \times 14 = 63$ tons. The diameter of those portions of the brake drums clipped by the straps is, however, about 20 ft., while the four straps are each 9 in. wide, so that the aggregate rubbing surface amounts to 188½ square feet, and the pressure between the surfaces would thus be but one-third of a ton per square foot, or but very little over 5 lb. per square inch, a pressure which we need scarcely say, is exceedingly small. Moreover, although the trains are three minutes descending the incline, the brake is not applied during the whole time, and probably even when the trains are being run at five minute intervals, quite three minutes elapse between the successive applications of the brake. Under these circumstances, and when the fanning action of the revolving drums is taken into consideration, it is not surprising that but exceedingly little heating should be noticeable.

The next papers read were one: "On a simple construction of Steam Engine Governor, having a close approximation to perfect action," by Mr. Jeremiah Head, and one "On steam boilers with small water spaces, and Root's Tube Boiler" by Mr. Charles Cochrane. The former of these papers we publish in abstract elsewhere in the present number. Mr. Head's paper was one of an exceedingly useful kind, its object being to show that by constructing governors with the pendulum arms crossing the spindle to points of suspension situated at the opposite side of the spindle to that at which the balls to which they respectively refer hang, an almost perfect action can be obtained, while this action may be still further improved by the addition of a spring so mounted on the spindle as to tend to assist in closing the balls. The advantages of crossed-arm governors are far from being so generally appreciated as they deserve to be, and we are glad, therefore, to see attention so ably directed to them by Mr. Head. During the week we have had an opportunity of examining Mr. Head's governors in use at the Newport Rolling Mills, and at the Britannia Iron Company's Works, and we can testify to their sensitiveness and exceedingly prompt action. Mr. Cochrane's paper was also of a thoroughly practical character, and elicited an interesting discussion. This we shall publish next week.

Owing to want of time, Mr. Edward Fletcher's paper "On the Breakage of Axles under Railway Rolling Stock," which had been announced, was not read, and the adjourned discussion on Mr. Marshall's paper "On the principal constructions of breech-loading mechanism for small arms, and their relative mechanical advantages," was also postponed until the next meeting. Wednesday afternoon, like that of Tuesday, was spent in visiting the Middlesbrough works, while yesterday an excursion was to be made to Stockton to inspect the works there, this being followed by a visit to the works at Eston Junction and to the Lackenby Works, the day being concluded by a dinner at the Zetland Hotel, Saltburn, given by the members of the Cleveland Iron and Engineering trades. Of the various works visited, our space will not permit us to give complete descriptions, but we subjoin brief accounts of a few of them, and we hope next week to have more to say concerning them.

THE BRITANNIA IRON WORKS.

The new works, which are the property of Messrs. B. Samuelson and Co., are now in a very advanced state, and they will, in fact, probably be in regular work in less than a week's time. They are intended solely for the production of rails, with their fish-plates, or similar accessories, and they will, when completed, undoubtedly form one of the finest rail-manufacturing establishments in the kingdom. The arrangement of the works is admirable, and it is evident that in the selection of the plant nothing has been rejected simply because it was new, but that rather every effort has been made to turn to account the results of the latest practice. The coal and pig iron are brought to the works by a branch from the North-Eastern Railway, and—with the exception of the coal used in the Siemens furnaces—are carried in the wagons along a slightly-raised embankment extending along one side of the works, and are discharged into a suitable range of bunkers. Parallel with these bunkers are four ranges of puddling furnaces, 30 furnaces in each row, or 120 in all, the shop containing this vast number of furnaces being 540 ft. in length. Between the first and second, and the third and fourth rows there is formed a subway, in which is laid a narrow-gauge line, on which can run the small wagons or "bogies" for receiving the ashes and cinder from the furnaces, these being discharged into the wagons standing in the subway through conveniently arranged shoots. The small wagons, on arriving at the outer end of the subway, will be lifted by a suitable hydraulic lift, and discharged into the larger railway wagons, by which the materials will be conveyed along. By this arrangement, which is exceedingly convenient, the nuisance of having wagons moving about amongst the puddling furnaces is entirely got rid of. The two central rows of puddling furnaces are provided with boilers heated by the escaping gases, these boilers being enlarged at their upper ends to give an increased water surface, and to enable them to be more readily entered for examination. The boilers form a series of groups of four each, the four boilers forming each group being connected by branches (each provided with a stop valve) to a single descending steam pipe, this pipe conducting the steam to a main pipe which extends from end to end of the range of furnaces beneath the floor line. This main pipe, however, is not laid in a continuous length, but is divided into three equal parts united by forked-pipes so as to permit of expansion and contraction. From these pipes steam is taken to the various engines and steam hammers, all the pipes being laid beneath the floor line in brick culverts, covered by loose cast-iron plates, so that although quite out of the way, the pipes are yet very readily accessible. The pipes are to be clothed throughout with a non-conducting composition, and steam traps are provided at suitable intervals to throw off the water arising from condensation.

In front of the ranges of puddling furnaces are two complete forge trains, these trains, which are in exact duplicate, each being driven by its own engine, and each having three 6-ton single acting steam hammers, made by Messrs. Thwaites and Carbutt, working in connexion with it. The engines of the two trains are of the horizontal non-condensing type, and are placed side by side at the centre of the range. They have each a 36 in. cylinder with 4 ft. 6 in. stroke, and drive the rolls direct, the speed being at present about 55 revolutions per minute. This speed is, however, we understand, to be reduced to about 45 revolutions per minute. These engines, as also those in the rail mill, of which we shall speak presently, were made by Messrs. Martin Samuelson and Co., of Hull, and they are fitted with Mr. Head's governor, of which we have already spoken. The fly-wheels of these engines are a particularly fine job, the rim of each wheel being cast in a single piece. The wheels are 22 ft. in diameter, and each weighs 34 tons. In front of each forge train is a pair of shears for cutting hot bars, while a powerful shearing machine for cutting cold iron is also provided.

The portion of the works we have already described is the only part yet in regular use, one of the forge trains being at work producing puddled bar; but the rail mill and other parts are, as we have stated, in an advanced state. The rail mill contains twelve—and will ultimately contain sixteen—Siemens furnaces for heating the piles, these furnaces being supplied with gas by thirty-two producers disposed in eight groups of four each. Close to these furnaces is being erected one of While's continuous blooming mills, with an engine for driving it; while a rail mill, constructed on Mr. Brown's plan, has just been put up. In this mill there are two sets of rolls, one behind the other, the two sets running in opposite directions. The working grooves in each set of these rolls are alternated with larger grooves, through which the bloom or rail can pass without being acted upon, the arrangement being such that the large grooves of one set of rolls come opposite the working grooves of the other. It follows from this arrangement that the bloom or rail can be passed backwards and forwards—being acted on the two sets of rolls alternately—without any reversing being required, and much time will thus be saved. Mr. Brown's mill has hitherto only been employed for very small sections, and its adoption for rail rolling at the Britannia Works is therefore to some extent an experiment; but it is undoubtedly one of much promise. This mill, we may add, is driven by a horizontal non-condensing engine, with 36 in. cylinder and 3 ft. stroke. Close to this mill are being erected the circular saws for cutting off the rails, and the straightening presses. The sawing arrangement consists of two saws mounted on one spindle, driven by a belt from a countershaft overhead, this countershaft being in its turn driven by a belt from a small independent engine. The saw spindle is carried by bearings mounted on a slide or carriage, which is moved forward, so as to bring the saws up to their work, by a steam cylinder, the motion being controlled by regulating the flow of water from one end to the other of an hydraulic cylinder containing a piston attached to a prolongation of the main piston rod. The arrangement is a very neat one. Adjoining the rail mill is a small engineers' shop and a smiths' shop, the former containing a lathe for turning rolls.

We have now given a general outline of the Britannia Iron Works, which will, we trust, serve to show their extent, while at some future time we hope to describe them completely. Meanwhile we may remark that their arrangement reflects the greatest credit upon Mr. J. J. Thomas and Mr. Richard Howson, under whom it has been carried out. In conclusion, we should state that the Britannia Works are calculated to turn out from

1300 to 1500 tons of rails per week when in full work.

THE NEWPORT BLAST FURNACES.

This establishment is also the property of Messrs. B. Samuelson and Co., and it may be considered as consisting of two distinct parts, the older part comprising five, and the new two furnaces. It is of this latter portion only—illustrating as it does Messrs. Samuelson's latest practice—that we propose to speak here. The two furnaces are each 85 ft. high and 28 ft. in diameter at the boshes, each furnace being blown with four tuyeres with 6 in. nozzles, and the blast being supplied at a pressure of about 5 lb., while the temperature at the time of our visit was 1100°. The furnaces are, of course, close-topped, the gas being taken off in the manner regularly adopted in the Cleveland district, and sufficing to heat the blast stoves and all the boilers. The materials are raised to the top of the furnaces by a steam hoist, consisting of a pair of cages connected to the opposite ends of two wire ropes, which pass over a drum, 12 ft. in diameter, provided with two grooves. The grooves are turned to fit the ropes, and the requisite grip is obtained simply by the ropes passing over, or half round, the drum. The hoist is driven by a pair of engines, with cylinders 8 in. in diameter and 12 in. stroke, these engines being situated at the blast furnace top, and the steam being led up to them. The crank shaft of the engines carries two pinions, one at each end, these pinions gearing into a pair of spur wheels on an intermediate shaft, and this shaft again carrying a pinion, which gears into teeth on the main winding drum. Judging from present experience, this plan of hoist appears to answer well, the ropes, which are of steel wire, showing no signs of wear.

Each furnace is provided with nine heating stoves, of which eight are in use at once, these stoves having cast-iron pipes of the straight form, with an internal partition now generally used in the Cleveland district. Blast is supplied by four vertical blowing engines coupled in pairs, each pair having its two cranks at right angles. Messrs. Samuelson work their engines with a much higher degree of expansion than is usual in the district, the steam being cut off at one-fourth the stroke, and the slide valves being provided with adjustable expansion valves at the back. The steam cylinders are 32 in. and the blowing cylinders 66 in. in diameter, while the stroke is 4 ft., and the pressure of steam used is about 55 lb. per square inch. The blast pressure is 5 lb. per square inch. The valves of the blowing cylinders are hanging flap valves, those of one pair of engines being of leather, and those of the other of india-rubber. The engines are supplied with steam by eight boilers, of which seven are in use at one time, these boilers, being each 35 ft. long by 5 ft. 6 in. in diameter, with a 2 ft. 9 in. flue. As we have said, the boilers are all heated by gas, the latter being first led through the flues and then caused to return under the bottoms of the boilers.

The calcining kilns are five in number, and are each 22 ft. in diameter by 40 ft. high. The wagons containing the ore are raised to the top of these kilns by a direct acting steam hoist, the cage being attached direct to the rod of a piston 38 in. in diameter, moving in an overhead cylinder of sufficient length for the stroke of 40 ft. To lift the load, which averages about 16 tons, the steam is admitted to the lower end of the cylinder, while during the down stroke it is allowed to escape from the bottom to the top of the cylinder to be forced out through a loaded relief valve, during the succeeding up stroke. This method of working by keeping the cylinder full of steam saves much cooling, and the plan is found to answer most satisfactorily. In conclusion we may state that the furnaces, of which we have been speaking, are making foundry iron, and are each running on an average 470 tons per week.

THE AYRESOME IRON WORKS.

Amongst the numerous works thrown open to inspection in Middlesbrough, the Ayresome Iron Works, belonging to Messrs. Gjers, Mills, and Co., deserve a special notice. Mr. Gjers is well known to have had a large experience as an engineer of iron works, and the Ayresome Works, which have only been a few months in operation, have been so planned by him that they form a model establishment illustrating the latest and best Cleveland practice. The wagons containing coke or ironstone are on arriving at the works raised about 34 ft. by a pneumatic lift, and thus brought on a level with the tops of the calcining kilns. These kilns are of the same pattern as those erected by Mr. Gjers at the Linthorpe and Tees-side works, and illustrated in an early volume of ENGINEERING; but they are of somewhat larger size than the latter.

The hoist by which the wagons are raised is also an improved copy of those erected by Mr. Gjers at the Linthorpe Works, the West Yorkshire Works, and other places. It is capable of raising, easily, a load of 19 tons, and consists of a pair of cylinders, or hollow columns, 4 ft. in diameter, placed one at each side of the platform to be raised, and carrying at their upper ends large rope pulleys, over which there pass four wire ropes connecting the corners of the platform to a pair of heavy pistons, these pistons working in the cylinders, and forming, besides, a counterbalance for the weight of the platform and load raised. The platform is raised by partially exhausting the air from beneath the pistons, thus causing them to descend in their tubes, while, on the other hand, the descent of the platform is caused by forcing air into cylinders beneath the pistons, the latter being somewhat heavier than the platform when the latter is light.

The works include at present two blast furnaces, each 85 ft. high by 25 ft. in diameter at the boshes, and two other furnaces of similar dimensions are in course of erection. The furnaces are not at present being worked up to their full capacity, but each is running on an average 400 tons per week. The materials are raised to the tops of the furnaces by a pneumatic lift constructed on the same principle as that used in connexion with the calcining kilns, but having one central cylinder 3 ft. in diameter in place of two cylinders as in the former case. The blast is supplied at a pressure of from 4¼ to 4½ lb., by blowing engines of the same pattern as those constructed from Mr. Gjers's designs for the West Yorkshire Works, and illustrated by us about sixteen months ago. There are two of these engines at the Ayresome Works, but one only is in use at one time. They have each 48 in. steam cylinders, and 96 in. blowing cylinders, while the stroke is 4 ft., and the engines are run at a speed of about 30 revolutions per minute. Steam is supplied by six boilers, of which four are worked at one time, these boilers, which are worked at 50 lb. per square inch, being each 60 ft. long by 4 ft. 6 in. in diameter. They are set with flash flues, and, as well as the blast heating stoves, are all heated by the gases from the blast furnaces. The blast is heated to about 1250°. We are compelled, by the demands upon our space, to give a very brief notice of these works this week, but we cannot conclude without remarking upon the great taste, as well as engineering skill, which has been displayed in designing their details.

The remaining works visited by us, we shall have to leave for notice in a future number.

THE 35-TON GUN.

THIS splendidly-constructed, but at present utterly useless weapon, hangs heavily on the hands of the Admiralty. "What will they do with it?" is the question constantly asked, but never as yet answered. To make a good gun of it would be to proportion the length to the bore by adding about 2½ calibres to its length. But it has been built to Admiralty orders, and to the restricted dimensions necessary for a turret. No blame, of course, attaches to Colonel Campbell's department, but we should like to have seen the gun turned out some 28 in. longer, and then have been handed over to the Admiralty to cut down to their dimensions. But of course the gun factory had to work to specifications and drawings, and they are not responsible if the fault of the gun lies in its shortness, which we believe it does. A short time since there was a talk of lengthening the piece, but then it would be useless for the very purpose for which it was built. So now it is to be re-bored from the present calibre of 11.6 in. to one of 12 in., with rifling of the same twist as at present. This, of course, will reduce the length of the powder charge, and if the Admiralty will only ignite the cartridge centrally, they may probably succeed in burning all the powder, and rendering the gun useful. We sincerely trust they will, but if they do not we confess our inability to suggest any other alternative than the lengthening of the piece and applying it to another purpose than that of arming a turret ship. It is, however, a patchy way of settling the question after all, and the worst of it is that there are a number of these same guns in a like predicament.

WELLINGTON PATENT SLIP COMPANY.—A company formed in Wellington has purchased the materials for a patent slip sent out by Messrs. Kennard to the Provincial Government of Wellington (New Zealand), and is about to erect the slip in Evans's Bay. The company has been registered under the Joint Stock Companies Act, 1860.

THE HARVEY TORPEDO.

THE crews of such ships as happened to be in the Yarmouth Roads last Saturday afternoon, either under sail or at anchor, were considerably astonished by their vessels being made the subject of attack by a small steamer armed with one of Captain Harvey's sea torpedoes. The results were of course harmless, as the torpedo was not charged, although it was fitted with the exploding apparatus. The object of the excursion was to test the capability of the crew of an ordinary merchant vessel to manœuvre the torpedo, and further to test the towing gear, and the certainty of action of the weapon when in use. A small paddle-wheel steamer—the Andrew Wodehouse—of the ordinary class, and of about 60 tons burthen, was engaged upon the occasion. The master and crew of the vessel worked the torpedo under the personal direction of Captain Harvey. The torpedo was one of a large number now being manufactured by the London Ordnance Works. It measured 3 ft. 8 in. in length, by 1 ft. 6 in. in depth, and 5 in. in breadth, weighing, when charged, about 1½ cwt. On the present occasion, water was used to bring it to the service weight. The slings and buoy rope were of hemp, the towing rope being of ¼ in. diameter iron wire, controlled by a small iron brake acting on the side of the drum on which the rope was coiled. As a temporary towing-yard, a spar was rigged across the quarter davits of the steamer on the port side, a leading block being lashed on for the tow rope to reeve through. For detailed particulars of the torpedo and towing apparatus we must refer our readers to page 35 of our last volume, where they are fully described with illustrations.

Thus equipped, the Andrew Wodehouse started on her cruise, towing the torpedo well out from her side at an angle of 45°, with from 20 to 50 fathoms of tow line. The cutwater of the torpedo was at all times sufficiently visible to those on board the vessel to permit its steadiness and uprightness to be observed. The first attack was made against a brig coming on under full sail. The brig yawed, but the torpedo was successfully dipped under her keel with about 30 fathoms of line out. The second attack was against a brig at anchor, with 30 fathoms of tow line out. The torpedo was again successfully dipped under her bottom, both the firing levers being driven home, piercing the detonating capsule. Succeeding attacks were made with similar and invariable success upon other vessels both under sail and at anchor, the torpedo being well manœuvred, and always planted effectually against the object of attack. The final experiment was made with the steamer running at the highest possible speed, in order to test the strength and reliability of all the towing gear. It was also desired to know how much of the wire rope could be effectually veered out from the temporary towing spar, which was about 15 ft. above the water. The steamer attained a speed of 11 knots, and the torpedo was well out from her side at 45°, with over 50 fathoms of tow line. Only a very few minutes were occupied in each attack, the time of striking being but a few seconds. The experiments were satisfactory, and went to show that if necessary our steam mercantile marine could, with little delay, and at a comparatively small cost, be transformed into a highly efficient offensive power. Although the enemy's guns, if ready, might be brought to bear on the torpedo craft, the latter has chances of escaping, as was proved by the experiments with the Camel tug against the Royal Sovereign, which took place at Spithead some months since, and which were reported by us at the time.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the usual weekly meeting of the iron market was held in the Royal Exchange, Middlesbrough, but in consequence of the meeting in connexion with the visit of the mechanical engineers being held at the same time, the attendance was exceedingly limited and scarcely any business whatever was transacted. Prices of course were unchanged.

The Finished Iron Trade.—Beyond the fact that all the works in the North of England are as busy as possible, there is nothing worth reporting in this branch of industry. Rails are in good request, and there is an excellent trade being done in shipbuilding iron.

The Nine Hours' Movement.—The failure to bring about a conference between masters and men at Newcastle last week with a view to terminating the strike seems to have done harm. Both parties seem as determined as ever to hold out. The men held a mass meeting on Saturday, and resolved to adhere to their resolutions previously passed binding them not to resume work except on the nine hours' system.

The Wages of the Iron Workers.—Mr. Hughes, M.P., who as the arbiter for the Board of Arbitration in the North of England Iron Trade was waited upon in London on Monday by a deputation from the Board, has since decided to send a London accountant down to the north to verify the statements of the masters respecting unexecuted contracts previous to giving his award.

UNION PACIFIC RAILROAD.—The net earnings of this undertaking to May 31 this year amounted to 1,274,346 dols., as compared with 730,780 dol. in the corresponding period of 1870.

CLEVELAND IRON MAKING.

*On the Preliminary Treatment of the Materials used in the Manufacture of Pig Iron in the Cleveland District.**

By MR. I. LOWTHIAN BELL.

THE three raw materials employed in the production of pig iron contain a portion of volatile matter. In the Cleveland district the fuel obtained from the collieries of South Durham is made up of fixed carbon and ash, combined with about 35 per cent. of substances which, when the raw coal is submitted to heat, escape chiefly in the form of combustible compounds of hydrogen and carbon. The ore contains about 28 per cent. of earthy substances, associated with about 31 per cent. of iron, chiefly in the form of carbonate of the protoxide. In this case, carbonic acid and oxygen, together with some water, constitute the volatile portions. The flux in carbonate of lime being almost pure, contains, therefore, 28 of caustic lime united to 22 of carbonic acid. Whatever be the condition in which these substances are delivered to the blast furnaces, the whole of the volatile portions referred to, viz., the hydrocarbons of the coal and the carbonic acid and water of the ore and limestone, are expelled long before the process of smelting is complete. This expulsion means work and absorption of heat, and hence the usual practice has been to perform the operation in apparatus of a simpler form of labour than that required for completing the process itself. Hence, when it is desired to separate the hydrocarbon from the coke, one or other of the different forms of coke ovens are employed; and when it is desired to rid the ironstone or flux of their carbonic acid, a kiln is used, in which the raw stone is introduced with a small quantity of the cheapest kind of small coal. When it is remembered that the volatile portion of the coal is highly inflammable, and, weight for weight, has a much greater heating power than the fixed carbon or coke portion, one can understand the regret which is often expressed at the loss of a quantity of heating material which on the make of pig iron in this district may be taken as equivalent to one million tons of coal per annum. The value of this quantity of fuel cannot be taken at less than 250,000*l.* at the pit's mouth, and therefore represents something like 4*s.* on every ton of pig iron manufactured by means of Durham coke from Cleveland ore. The paper then dealt fully with the consideration of the nature of the operation of smelting as it is effected in the blast furnace, and pointed out what the condition of the materials ought to be at the period of their being charged at the top. After alluding to the Appolt coke oven, and other ovens in which the gases were consumed in flues surrounding the coking chamber, Mr. Bell stated that, notwithstanding the difficulty which existed in instituting a very rigid comparison between two different kinds of fuel in blast furnaces, he was in favour of coke made in the ordinary oven. Hitherto they had regarded the blast furnace as engaged in merely melting the iron and slag, for which a certain quantity of heat was required. This heat in round numbers for foundry iron might be regarded as that resulting from the combustion into carbonic oxide of 20 cwt. of average quality of coke burnt with air heated to 850° or 900° Fahr. Whatever might be the loss of fuel in the upper part of the furnace, they must bear in mind there must be at disposal this quantity of coke more or less at the tuyeres. The result of the action of the oxygen of the blast was carbonic oxide, which was the substance that might be regarded directly or indirectly as exclusively affecting the reduction of the ore, and it might be added supplying the carbon found in the pig iron. After discussing the question whether there would be any advantage in relieving the blast furnace of this portion of its work by introducing the ore in which the iron is contained already in a deoxidised state, Mr. Bell stated that there was no doubt that the application of any process which would remove from the blast furnace every trace of carbonic acid would cause the process to be less dependent upon the nature of the sources of the heat than was the case at present. If it were possible to heat the blast still higher than 1400 deg., the 1¼ cwt. of coke per ton of iron made would be so much increased; but dealing with the question according to present experiences, the additional cost of the preliminary deoxidation of the ironstone would appear to be too much to render its adoption advisable, inasmuch as the margin of saving, by avoiding the presence of carbonic acid on the furnace, is compressed within 1¼ cwt. of coke per ton of iron when the blast is heated to about 1400 deg. In conclusion, Mr. Bell was of opinion that there was little economy of fuel to be hoped for by the use of raw coal, or by using the ironstone and limestone calcined instead of raw.

* Abstract of paper read before the Institution of Mechanical Engineers at Middlesbrough.

THE "ANNALES INDUSTRIELLES."

TO THE EDITOR OF ENGINEERING.

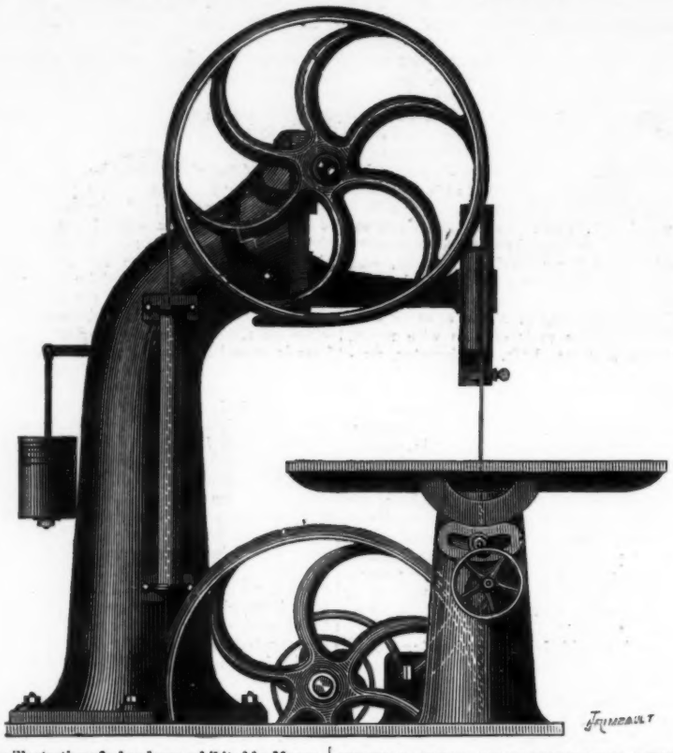
SIR,—The *Annales Industrielles*, whose publication has been interrupted during recent events, will reappear on the 1st of August following. In the difficult situation in which affairs have placed us, to mutilate two volumes together has seemed to us an arrangement as unfortunate for our readers as for the publication itself. We have thus thought it better to consult interests so closely united, by deciding on a very simple course, and publishing the monthly parts for 1871 in lieu of those which did not appear in the corresponding period of 1870. We shall thus avoid all chance of irregularity in the service of distribution, and shall, we hope, cause as little confusion as possible.

But the number for the 1st of August, 1870—now completed a year since—will appear with its proper date, the change of which would render inexplicable some articles it contains; the subsequent numbers will be dated 1871.

Yours truly,

Paris, July 25, 1871. A. CASSAGNES.

ROBINSON'S BAND SAW.



WE annex an illustration of a band saw exhibited by Messrs. Thomas Robinson and Sons, of Rochdale, at the recent show at Wolverhampton, and briefly referred to by us last week. This saw does not include any particularly novel constructive feature, but it is worthy of notice on account of its very neat general design and good proportions. The framing, we may remark, is hollow and is of an elliptical section, and while very rigid it has a light appearance. The tension of the saw is maintained by a weighted lever acting on the top pulley, while the table has an angle motion both ways for bevel cutting.

TRAMWAYS.

TO THE EDITOR OF ENGINEERING.

SIR,—It was with great pleasure that I read your able article on tramways last week, considering that the subject is one which is every day rising into greater importance.

After considerable opposition the Edinburgh Tramway Bill has passed, and several lines are to be proceeded with at once. Now as is well known several of the principal thoroughfares of the city have gradients of 1 in 8 and even steeper in some places, and as the traffic is to be worked by horses, with such gradients, the number can be very little reduced from what it is with the present omnibuses, for though the rolling resistance may be less with the tramway cars, the resistance to gravity remains the same; this coupled with the enormous first cost, something about 7000*l.* per mile, will put the company in such a position that they will not be able to convey passengers under the existing rates. What, then, are the public to gain, to balance all the inconvenience caused in the streets by the tramway cars?

Perhaps it is not generally known to your readers that the question is being practically solved in this neighbourhood in the very way you advocate, viz., steam propelled cars without the use of a tramway.

There has now been running from Edinburgh to Portobello and through one of the principal streets of the city a steam omnibus, for two months past, carrying 50 passengers.

Contrary to prediction, not the slightest accident has occurred, and from its special construction the horses on the route pay little attention to it. The speed is of course restricted by the Road Locomotive Act, and is faithfully carried out even to the red flag; still it is considered a success, and if so on ordinary causeway or macadam roads, how much greater would it be on asphalte or some kindred substance? This is evidently the future of street railways.

I am, Sir, yours truly,

July 25, 1871. J. R.

[Our correspondent is mistaken in stating that we advocated the general employment of steam propelled cars without a tramway.—ED. E.]

INTERCOLONIAL RAILWAY.—Section No. 24 from Amherst to River Philip is entirely graded, with the exception of three or four points where large structures are under way. Three-fourths of the line could be laid with rails now if they were available for laying. No. 4 section, 27 miles in extent, is the longest on the line and as difficult, upon the whole, as any; it also suffered the drawback of having to be re-let. It has now, however, made good progress.

TREDGOLD'S ELEMENTARY PRINCIPLES OF CARPENTRY.

TO THE EDITOR OF ENGINEERING.

SIR,—We are sorry to see that Messrs. Lockwood and Company, in criticising Mr. Hurst's edition of Tredgold's Carpentry, have, we are quite sure unknowingly, misstated the date of the edition of Tredgold's Carpentry used by Mr. Hurst. Mr. Hurst's book, as stated on its title-page, is framed upon the original edition of Tredgold's Carpentry, published in 1820, and now 22 years out of copyright. In reprinting a book that is out of copyright we are only exercising a legal right and following the same custom an engineering firm adopts at the expiration of another's patent. In spite of what Messrs. Lockwood may say as to the morality of the proceeding, it is very generally practised in the publishing trade and is perfectly fair and honourable. Permit us to state that Mr. Hurst's book is a revision of the original edition of 1820, it contains a great deal of new matter as well as the results of many new experiments including some furnished by Mr. Kirkaldy, and some from private sources, in fact the revision has been so complete that it is "more the work of Mr. Hurst than of Mr. Tredgold." We have also endeavoured in every possible way, by altering the size, style, and binding, to prevent any one from confounding it with Mr. Barlow's edition, and we think it unfair of Messrs. Lockwood to do so.

Apologising for thus troubling you,

We are, Sir, yours obediently,

E. and F. N. SPON.

48, Charing-cross, July 25, 1871.

INDIAN COAL.—Major Bonus, R.E., has expressed a favourable opinion of Nerbudda coal. In a recent experiment made with it, 34 tons carried a train weighing 439 tons 19½ miles within an hour. The trial took place, of course, upon the Great Indian Peninsula Railway, which runs at no great distance from the Nerbudda deposits. Coal has been discovered at Condeconda in the Nizam's dominions.

THE NANTYGLO AND BLAINA IRON WORKS COMPANY.—A company is in course of formation for the purchase of the Nantyglo and Beaufort Iron and Coal Works, as well as the Blaina Iron Works, until lately the property of Messrs. J. and Crawshay Bailey, by whom it had been held and successfully worked for about half a century. The estates contain a total of 5000 acres, and the total pig iron production has averaged 1600 tons per week. About 650 tons of finished iron is turned out weekly at Nantyglo, and at Blaina the capacity is equal to 700 tons, with easy means of extension. The coal and ironstone supplies are practically inexhaustible, and the railways and tramways, surface and underground, are 300 miles in length. The capital of the company consists of 500,000*l.* cash, and 250,000*l.* shares, the latter of which go to the proprietors, together with 400,000*l.* in cash, leaving a balance of 100,000*l.* working capital for the company. There is no doubt that the price at which this vast property is offered is very low, some 400,000*l.* below the estimated value, whilst the extensive business and the great resources of the works make the question of its future prosperity entirely one of able management.

FISKEN'S STEAM PLOUGHING TACKLE AT THE WOLVERHAMPTON SHOW.

CONSTRUCTED BY THE RAVENSTHORPE ENGINEERING COMPANY, MIRFIELD.

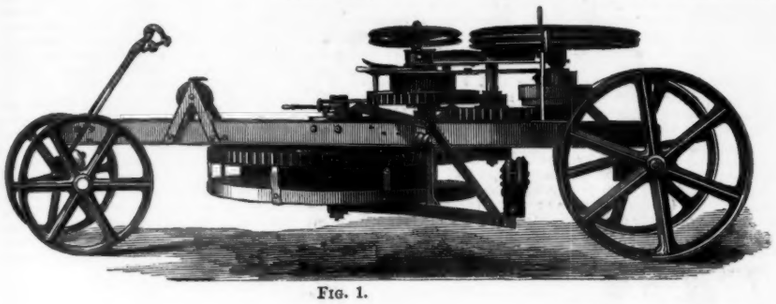


FIG. 1.

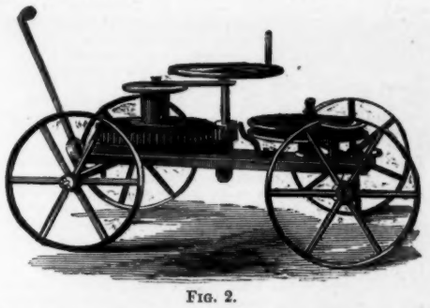


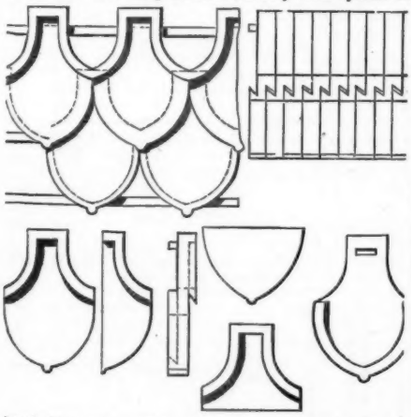
FIG. 2.

FIG. 3.

WE illustrate, above, the details of Messrs. Fisken's steam ploughing tackle referred to in our account of the Royal Agricultural Society's Show at Wolverhampton, contained in our last number. Fig. 1 of the accompanying illustrations shows one of the travelling windlasses worked by the fast-running rope; Fig. 2 shows the tension anchor, by the aid of which the fast rope is maintained at the desired degree of tightness, and Fig. 3 shows one of the light rope porters, and also one of the anchor pulleys, round which that rope is passed at the corners of the plot under cultivation.

ROOFING TILES.

MESSRS. WADE AND CHERRY, of Hornsea, Hull, exhibited at the late Wolverhampton Show, a very neat system of



interlocking tiles, which are locked together in such a manner as to render displacement by wind impossible, and are not dependent upon pointing. Messrs. Wade and Cherry manufacture these tiles by their patent brick and tile press, which is also exhibited, and which forms a very compact and effective little machine. The sketch, which we annex, will explain the form of these tiles more clearly.

TASMANIAN MAIN LINE RAILWAY.—No progress appears to have been yet made with the practical realisation of the Tasmanian main line railway scheme. The English capitalists who had taken the matter in hand require some further concessions and privileges, so that at present there is a hitch in the whole affair.

THE SUEZ CANAL.—The administration of the Suez Canal—which may, perhaps, be said to begin and end with M. de Lesseps—has been proceeding during the last few months with sundry supplementary works; and the canal has now a minimum depth of 26 ft. 8 in. throughout. The traffic is considered to be slowly increasing, but as it has not been sufficient to meet the last two half years' obligation interest, recourse to a loan is contemplated in order to meet this payment. No sale of the canal has been effected.

RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 2136, 1s.) Jan Wonzniakowski, of St. Petersburg, patents an ingenious automatic boiler feeding apparatus, the details of which we could not explain clearly without the aid of drawings.

(No. 2145, 10d.) William Alfred Gibbs, of Gilwell Park, Essex, patents improvements in his grain drying apparatus already described in our pages.

(No. 2149, 4d.) Thomas Carr, of Bristol, patents the manufacture of flour, by subjecting the grain to the action of any suitable continuously acting beaters travelling at a suitable speed and striking the wheat while the latter is unsupported. We doubt whether this mode of producing flour can be considered a novelty.

(No. 2153, 6d.) William Robert Lake, of Southampton-buildings, patents, as the agent of William Henry Jewell, of New York, forming lubricating cushions for railway carriage axle journals, by "enclosing any fibrous elastic substance that has the property of absorbing oil and delivering it upon any object with which it may be brought in contact within a sack made of some suitable texile or other fabric." We see nothing new in this idea.

(No. 2162, 4d.) George Brown, of Sheffield, patents a mode of manufacturing an artificial substitute for spiegeleisen. This plan consists in charging a cupola with manganese and iron mixed with more or less coke, charcoal, or other carbonaceous matter, the manganese being placed between the carbonaceous fuel and the iron, so that the latter in melting passes rich in carbon through the manganese, the effect being stated to be that the metal becomes gradually and regularly impregnated with the manganese and issues from the furnace having the appearance and possessing the qualities of spiegeleisen.

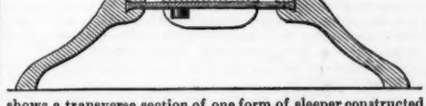
(No. 2168, 10d.) George Warsop, of 9, Barton-street, Nottingham, patents a condensing arrangement applicable to steam engines or to engines worked with a mixture of steam and air. According to these plans, in place of a condenser and air pump being employed as usual, the exhaust steam is led into a large condensing cylinder in which a piston works, this piston having a slight lead on the steam piston in the main cylinder. When the stroke of the condenser piston is nearly complete, an injection valve on the side of the cylinder opens and admits water into the latter, this water together with that resulting from the condensation of the steam and also any air which may be present, being expelled from the cylinder through suitable valves at the return stroke of the piston. It will be seen that this arrangement is really simply an inferior kind of compound engine in which the condensation of the steam is effected within the larger cylinder, the loss of heat to which the latter cylinder is thus subjected more than compensating for any advantage derived from the getting rid of a separate air pump. When an engine is worked with a moisture of air and steam, the effect of this loss of heat, however, will not be so great as in the case of an engine worked by steam alone, and there may, therefore, be certain cases in which the arrangement of which we have just spoken might be applied to aëro-steam engines with advantage. Even in such instances, however, still better results would be attained by resorting to the compound system in a good form, or by increasing the size of the first cylinder so as to obtain a greater expansive action, and applying a good form of ordinary air pump and condenser.

(No. 2184, 1s. 4d.) Max Eyth, of the Steam Plough Works, Leeds, patents the simple and effective arrangement of reversing gear, illustrated and described by us on page 267 of our last volume.

(No. 2187, 8d.) George William Hick, of Leeds, patents methods of constructing screws for cork, grain, &c., with bars having a rotating or oscillating motion imparted to them.

(No. 2196, 8d.) Robert Morton, of Stockton-on-Tees, patents one of the arrangements of refrigerator for cooling wort, &c., illustrated by us on page 321 of our tenth volume.

(No. 2197, 8d.) John Edgar Lowe, of 2, Laurence Pountney Hill, patents forms of cast-iron railway sleepers in which the rail instead of resting directly upon the rigid sleeper is supported on wrought-iron bridge pieces, or pieces of plate iron, the ends of which are secured in the sleeper during the process of casting. The annexed sketch



shows a transverse section of one form of sleeper constructed on this plan. The object of employing the bridge pieces is to give to the rail a slightly elastic bearing.

(No. 2212, 1s. 6d.) John Henry Johnson, of 47, Lincoln's-inn-fields, patents, as the agent of Jean François Cail, of Paris, an arrangement of machinery for extracting the juice from sugar-cane. According to this plan, the cane is passed through several pairs of crushing rolls, and is during its course moistened with a regulated quantity of water, while, finally, after leaving the last pair of rolls it passes on to an endless travelling apron by which it is carried off, being prevented from rising during its passage by pressing rollers above. Methods of applying these plans to ordinary three-roll mills are also included in the patent.

(No. 2217, 8d.) George Huntriss, John Swinburn, and James Wilson, of Barnsley, patent a method of supplying illuminating gas to mines or other places situated much below the level of the gasholder. According to these plans, the gas is forced down a pipe leading to the mine, &c., by the action of a steam jet, the steam being subsequently separated from the gas by condensation. We see no reason why the plan should not work well, and it has the advantage of being exceedingly simple.

(No. 2219, 8d.) Osborne Reynolds, M.A., of Debach, near Woodbridge, patents the very simple and useful match making machine which was exhibited by Messrs. Wood, Cocksedge, and Warner, at the recent Wolverhampton Show, and which we noticed in our last number.

(No. 2220, 2s. 2d.) Martin Macdermott and Arthur David Williams, of Scott's-chambers, Pudding-lane, patent some well-arranged machinery for twisting metal bars for forming augers, &c. We may perhaps illustrate this machinery in a future number.

(No. 2224, 1s. 2d.) Nicholas Demetrius Spartali, of Liverpool, patents some curious arrangements of air compressing machinery, the advantages of which we have failed to discover. Mr. Spartali appears to consider that some great good is to be gained by forming his discharge pipes with alternate contractions and enlargements. We don't.

(No. 2226, 1s. 2d.) Woodford Pilkington, of Balham, patents various forms of elastic wheels for traction engines, &c., these including amongst others that described and illustrated by us on page 119 of our last volume.

PEAT FUEL.

TO THE EDITOR OF ENGINEERING.

SIR,—It is satisfactory and useful to find that the correspondence in your columns between Mr. Pinchbeck and myself, has led to such a *résumé* of the whole subject as we have been favoured with in the communication of Mr. Leavitt, of Boston, U.S., published in a recent issue. This gentleman is the originator in the United States of the system that bears his name, and it is the one which there has attracted most notice by its practical results. I shall assume that this communication from Mr. Leavitt sufficiently disposes of the "washing" system as a commercial proposal; while for the strictures passed by Mr. Leavitt upon Mr. Pinchbeck's letter of the 19th of May last, that gentleman must be himself responsible. Premising thus far, a few remarks occur to me as called for by some portion of Mr. Leavitt's letter, for which I trust you will kindly find space, as the subject now presents itself in your columns in a shape really calculated to advance the interests of peat manufacture, upon the only rational principles yet developed for its production as a legitimate commercial business.

In my letter of the 12th of May last, page 345 of your journal, I instanced, amongst others, the Leavitt machine in America as one of the class that gives extensive practical results from the carrying out of the process of the maceration of the peat; and in reference no doubt to my remarks illustrative of this maceration, Mr. Leavitt says: "All those methods that involve pugging, rolling, kneading, cutting, and stirring, tend to break up the cells and tubes of the raw peat referred to, and of course discharge the air in some measure, but no mere pugging will effectually accomplish this, nor properly fit it for the subsequent stages of treatment." Now, as I appeared in the correspondence referred to as the advocate, and as far as in my power, the exponent of the pugging and macerating process, it may be inferred from Mr. Leavitt's remarks that I advocated no more than a "mere pugging" of the raw peat, and that thence arose the necessity for his more extended development of what was necessary in the preparation of the raw material. I take the liberty of reproducing what I wrote, and perhaps repeated, in my letters in my wish to place the matter as unmistakably plain as in my power before your readers:

"The object of the process is, not amalgamation, but the tearing asunder, the breaking up, the macerating of the whole mass of the peat for the twofold purpose of facilitating the escape of the water contained in it, and the reducing of the fibres to a condition in which they are no longer unfavourable to the shrinkage of this peat pulp in drying."

I do not see how an exposition such as this by me could be construed into a mere pugging process—the more particularly as in the correspondence no one appeared as an advocate for simple pugging. When I referred to the apparatus generally used, I styled it *a suitable* pug mill arrangement, as it is upon that principle mainly that the German "Torfpressen" of Schlickeysen are constructed.

I may give you the words used hereon by an able writer in the *Polytechnisches Centralblatt*, August, 1865, page 980. Referring to this macerating mode of treatment, he says:—"Von den genannten Vorrichtungen dürfte der Schlickeysen'sche *Thonschneider* in den meisten Fällen den Vorzug verdienen."

It will, therefore, be seen that upon the principle of the maceration of the raw peat, Mr. Leavitt and myself are entirely agreed; and if that gentleman or any of your readers can conveniently turn to the report of Dr. Dullo—"Torf-verwerthungen in Europa:"—Berlin, Gustav Bosselmann, 1861—pages 2 and 3, before referred to by me, and to his description of Weber's system at Staltach in Bavaria, pages 5 to 14 of same report, it will be seen that as far back as 1860 the principle of submitting the raw peat to a macerating process was being realised in Germany, and its rationale well understood and appreciated there.

The construction of machines for the purpose very soon afterwards engaged the attention of C. Schlickeysen, of Berlin, a maker of brick and tile machinery, and he effected such modifications and arrangements upon the system of his brick machines, that a very useful machine known as his "Torfpresse" was introduced, and from time to time so improved by him that this system of preparing peat fuel is now generally known by his name upon the Continent. Of course, all this does not detract from the rare merit of the independent working out of the same principle though by a different, and perhaps a much improved arrangement by Mr. Leavitt, in America in and after the year 1864.

Every well-wisher of peat realisation must hail the Leavitt machine as an independent testimony on a large, a sound, and a practical scale, to the value and worth of the macerating process, but at the same time we should not overlook what had been done previously in the same direction elsewhere, or omit to inquire into the progress which this industry has since made upon the Continent upon Schlickeysen's system. It remains for me to hope that Mr. Leavitt's communication and this letter will, through the ubiquity of the press and your editorial kindness, meet the eyes of Mr. Schlickeysen or some of his friends in Germany, and that they will favour your readers with some account of peat and its manufacture, from its present stand-point in that and neighbouring countries of the Continent.

In England the principle is best represented by Mr. Danchell, and we shall hope that he, too, will in due time add his experiences and results to what I may now better call a peat conference, than a peat discussion, in your columns, and not the least of its utilities will be such a summarisation of the present position of the peat question as will give those of your readers interested in it, the results upon extensive practical scales, of the best considered efforts, of the best men, working in the wisest directions, for the commercial utilisation of peat for fuel.

Your obedient Servant,
J. M. C. MEADOWS.

Modubeagh, Athy, July 17, 1871.

TO THE EDITOR OF ENGINEERING.

SIR,—I have read with great interest and pleasure the admirable letter in a recent number from Boston, Massachusetts, by Mr. T. H. Leavitt, who has in a manly, fair, and straightforward statement fully developed that peat properly selected and properly manufactured by powerful machinery, will produce a fuel, which is immensely more advantageous and beneficial for steam producing purposes than coal, or any other known fuel now in ordinary or general use for that purpose.

To develop this fact, permit me to state that I have personally devoted nearly twenty years of time and considerable thought and practical treatment of peat conversion into a commercial fuel, and after considerable expense in examining and investigating this important subject, I have arrived at a practical conclusion, borne out by practical experiments and results, that it requires good selection of peat of an available quantity combined with proper machines to produce a dense material in the best form or shape (which I consider best in a ball form or sphere) divested of water and air, as a fuel which shall act as an auxiliary, if not entirely supersede the present use of coal, &c., as steam generators. That the time for its application has arrived, is proved by the increased interest and demand for its commercial supply to steam packet companies, railways, manufacturing purposes, governmental uses in the navy dockyards, &c., but unfortunately there is no real encouragement given, or even offered to any practical inventor (like myself) to mature and advance the actual working and conversion of peat into a fuel, except it is by promises of patronage and aid when it is not wanted, that is, when the inventor can produce and supply the fuel ready for the great market which is awaiting its produce at his own cost and outlay.

Capital is abundant, but there is so much reserve of it in the hands of monopolists and usurers, that for real practical application it may be compared to unspread manure rotting uselessly in the farm-yards.

Surely this lamentable condition of things and want of useful action will not be allowed to continue after what has been so clearly shown by Mr. Leavitt, that a great profit and a public benefit and advantage can be surely obtained by converting useless peat bogs into farm lands, and supplying a splendid fuel in the shape of condensed peat. Trusting my appeal may not remain unnoticed for aid of liberal capitalists and helpers in this cause,

I am, Sir, yours respectfully,
W. AUSTIN, C.E.

17, Bristol-terrace, Bermondsey Park, July 18, 1871.

THE EMPLOYMENT OF SURVEYORS.

TO THE EDITOR OF ENGINEERING.

SIR,—The Committee appointed by the Council of the Royal Institution of British Architects to consider the question of the Employment of Surveyors in accordance with the resolution of the General Conference of Architects, 1871, having authorised us to collect from all available sources reliable information respecting the appointment and employment of surveyors in reference to building works, we desire to avail ourselves of the publicity of your columns to invite the attention of architects, builders, measuring surveyors, and all others interested in this important question to the inquiry now being conducted, and to ask from them the immediate communication of detailed information as regards general principles on their own special practice.

We shall feel obliged by any communications on this subject being addressed to us at 7, Whitehall Yard, S.W.,

And are, &c.,
ARTHUR CATES and T. M. RICKMAN.

July 20, 1871.

TITANIUM AND IRON.

TO THE EDITOR OF ENGINEERING.

SIR,—In a letter from "E. T.," in your issue of the 14th instant, he says that he has analysed several of the most important Cumberland ores, but has "failed to detect any titanic acid whatever in them. The compounds of titanium found in the hearths of furnaces (in Cumberland) is accounted for by using Irish ores which generally contain 2 or 3 per cent of titanic acid."

I am not a practical chemist, and cannot say that I have either looked for or found titanic acid in Cumberland ore; but I can say that the largest piece (several pounds weight) of what was then called titanium which I have ever seen was got 10 years ago out of the hearth of a furnace at the Cleator Moor Iron Works, where then, as now, no Irish ores are used, but only the highest class of Cumberland ore chiefly from Big Rig Moor.

I am, Sir, your most obedient Servant,
Whitehaven, July 17, 1871. HEMATITE.

THE ST. LAWRENCE.—It is stated that the United States Government has appointed fifteen engineers to survey the St. Lawrence between Kingston and Lachine. A steamer has been chartered at Morrisburg for the use of the engineers.

MELBOURNE WATER WORKS.—Colonel Sankey has arrived in Victoria from India for the purpose of reporting upon the Melbourne Water Works. The gallant Colonel having visited the Malmsbury reservoir, the Black Creek syphon, and other portions of the works belonging to what is known as the Coliban scheme, has sent in a report in which he has suggested the adoption of measures to secure the works at the Malmsbury reservoir against further damage during the coming winter. Colonel Sankey has approved of a proposition to brick-line or, rather, to sheath the outlet tunnel, and for this purpose a shaft is now being sunk; he also recommends some further repairs to the byewashes. These recommendations have been adopted by the Colonial Government, and the necessary works are being vigorously prosecuted.

FORGED SCREWS.

THE holding power in timber of screws on which the thread is forged instead of being cut was tried at Lloyd's public test at Low Walker, near Newcastle-on-Tyne on the 23rd ult. These screws are the patent of Messrs. Henry P. Boyd and Co., Limited, and are manufactured by them at Low Walker-on-Tyne. They are adapted for railway chairs, tramways, composite ships, deck fastenings, &c., but the following investigation has special reference to their fitness for armour plates, and is based on the data of Rankine's rules. Taking Test No. 2 from the annexed Table the screw was 1 in. diameter of body, 1⅛ in. diameter over the thread, and 1⅛ in. pitch of thread. The fibre at the skin of the iron follows the sectional contour of the thread. The base of thread measures ⅛ in., and the internal ⅜ in. The face of thread is square to body of screw, the edge sharp, and the back bevelled. The screw in this test was entered 12 in. into the timber, and 12 in. of screw gives 10 turns of the thread. Taking pitch circumference and slope as radius, tangent and secant we have 1⅛th minus ⅛th, 3.1416 minus ⅛th, and final secant 2.925, which plus ⅛th equals 3.335 in. theoretical spiral, mean length of thread 40 into $\frac{8}{10}$ equals 7.5 square inches area in face of thread.

Now as the screw broke at 22 tons the strain on the body of screw was 62.489 lb. per square inch before stretching, and the pressure on the face of thread was 6.572 lb. per square inch, and the shear on base of thread was 5.973 lb. per square inch. It will be observed that the iron in the thread was working at only about $\frac{1}{10}$th of its ultimate strength.

We have next to see how the timber is enabled to hold the screw against 22 tons; the hole is 1 in. diameter bored 12 in. deep with ⅛th auger, and the screw put in by two men with a spanner acting on a squared head. Ten laps of timber in the intervals of the thread, measured at the circumference of the thread, is 44 into ⅝ equal 35.5 square in. area for shear across fibre of timber without taking account of the crushed timber behind the threads. At 22 tons pressure this gives 1280 lb. per square inch, which amounts to only about ⅓rd of the shearing strength of teak. It may be remarked that the ordinary cut screw has a close thread which disintegrates the timber so that it is easily drawn out.

The method of applying these screws in the construction of composite ships is to screw the iron frames to the timber from the inside, and the keel is at once ready for the copper sheathing. The forged screw is not only a stronger fastening than the bolt and nuts, as shown by experiments, but in using it the planking is not weakened by being cut through, and the expense of dowelling (and of brass screws in war ships) is saved.

In conclusion it only has to be noted that the advantage of fixing without a nut can only be had from screws forged by Boyd and Co.'s process, which so increases the toughness of the thread, that it can be kept of wide pitch, whereby the wood is not crushed to the same extent as by ordinary cut screws.

Armour Plate Forged Screws Manufactured to 2¼ in. Diameter and Upwards.

Number.	Length entered and diameter of body.	Diameter over thread.	Brand of iron	Timber used.	Strain put on.	Remarks.
3	10×1	1⅛	B B H	Green heart	19¼ tons	screw broke diameter 1⅛.
2	12×1	,,	Bowling	Teak	22 ,,	screw broke neck reduced to ⅞ diameter.
1	12×1	,,	L W B B B	American oak	23¼ ,,	screw broke drawn out; wood found faulty.

Railway-Chair Forged Screws Tested in Comparison with Ordinary Twisted Spikes.

Number.	Length entered and diameter of body.	Diameter over thread.	Brand of iron.	Timber used.	Strain put on.	Remarks.
4	4½+⅜	⅝	Refined iron	American oak	3½ tons	screw broke.
5	,,	,,	,,	Yellow pine	⅝ ,,	drawn out.
6	4½+⅝	,,	,,	American elm	3½ ,,	,,
7	,,	,,	,,	Yellow pine	2½ ,,	,,
8	5+1⅛	1	,,	American elm	5½ ,,	,,
9	,,	,,	,,	Yellow pine	3½ ,,	,,
	Spikes.					
10	1 ⅝ square	⅝	...	Yellow pine	...	drawn out under 5 cwt.
11	2 ,,	...	...	,,	...	drawn out under 5 cwt.
12	2 ,,	...	...	American elm	2½ tons	drawn out.

NOTE.—The one ⅝ in. screw (in No. 5), weighing 4 lb, sustained a strain three to four times greater than the two spikes (in No. 11) weighing 2½ lb., yellow pine being used in both cases.

THE NORTH GERMAN LLOYD.—The North German Lloyd Steamship Company has ordered the construction of two first-class steamers. One of the new steamers is to be employed on the New Orleans line, and is to be 50 ft. larger than the Koln; the second will be devoted to the New York line, and will be 20 ft. larger than the Rhein. The company's direct service to New Orleans will be resumed by the end of September.

GRAMME'S MAGNETO-ELECTRIC MACHINE.

FIG. 1.

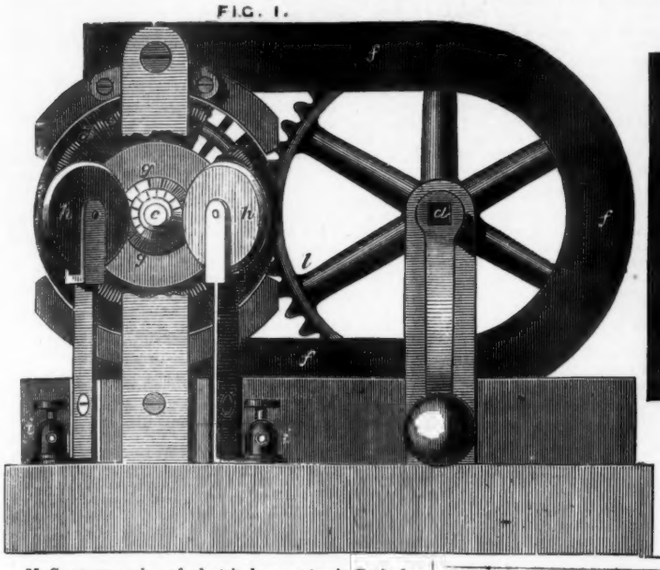
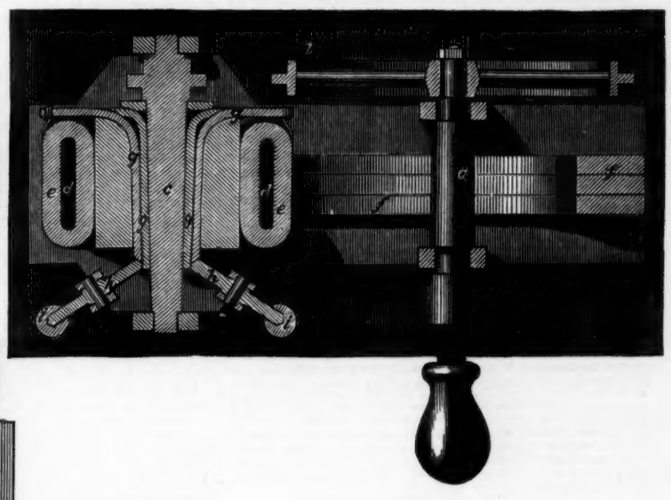


FIG. 2.



M. GRAMME, maker of electrical apparatus in Paris, has just produced a machine which transforms motion into a continuous induction current. This invention is important, both from a practical and a theoretical point of view. Hitherto there had only been obtained induction currents of a very short duration, and electro-magnets comprised in general of parts more or less complicated commutators to inverse the half of these currents, whose intensity varies, and give little continuity or constancy. Such are the apparatus of Pixii and of Clarke, such are also the magneto-electric machines of Henley, of Siemens, of Ladd, employed on telegraphs, and of the Nollet machine, known under the name of the Alliance Company's machine, and to-day the most generally used to produce the electric light.

To explain the principle of the invention of M. Gramme, we will allude, first, to the ordinary modes of producing induced currents. Given a metallic coiled thread: if a magnet be introduced into the interior, it will produce in the circuit a current which can be made apparent by the aid of a galvanometer. The current commences when the magnet is sufficiently near the circuit; it has an intensity more great as the magnet is introduced more rapidly into the coil, it ceases when the magnet has arrived in its place in the coil. If the magnet then be withdrawn, a reverse current manifests itself under the same condition of duration and intensity.

The same phenomena are produced if a bar of soft iron being placed in the coil a magnet is approached or withdrawn, which excites the bar. Let us suppose now that the coil and the soft iron inside have a great length; if a magnet be moved with a constant speed along this electro-maguet, the induced current will last during the whole time of the movement, and will preserve a constant intensity. If we give now to the electro-magnet a circular form, and cause the electro-magnet to turn in such a manner that one of its poles follows the circumference of the annular coil, we shall realise the continuity of the induced current. It will be the same thing if, the magnet remaining fixed, we make the annular electro-magnet turn round on its axis. Such is the theory of the new machine we illustrate above. The soft iron has the form of a plate, with its corners rounded, and rolled in the form of a ring. It is surrounded with 200 metres of copper wire of 2 m. m. in diameter, wrapped in silk. There are three horse-shoe magnets, as shown, in juxtaposition, whose poles carry the two concave armatures, *f*, embracing, with two diametrically opposed arcs, the cylindrical surface of the annular electro-magnet, *d*. One of these armatures develops in the circuit a current of a certain intensity, whilst the other armature produces in the opposite part of the same circuit a reverse current of the same intensity. All that is necessary to collect this current is to place in the neutral points of the surface the middle of the two armatures two rubbing pieces in metallic contact with the coil; they will take, the one the positive electricity, the other the negative, and will form the two poles of the electric generator. If the circuit enveloping the soft iron ring were formed of a single layer of copper wire, it would be sufficient to coil it on a thin circular plate, and to bring the rubbers on this circumference; but as there are several thicknesses of wire on the ring, it is necessary to resort to expedients to collect the electricity produced.

Let us suppose the circumference of the arc divided into two equal parts. One of the arcs thus divided is covered with copper wire to the desired thickness; then without cutting the wire, it is rolled up on the next arc until it has received a sufficient number of layers; then the third, but always without breaking the wire, and so on. The wire is stripped at each of the passages from one arc to the next, and there is attached to it a large brass wire, which follows a radius towards the arbor of the instrument. Each of these wires is bent at a right angle along the surface of this arbor, and following its axis, and, isolated one from the other, form, as it were, a sheath around the arbor, turning with the coil, and it is on this sheath which the two metallic wheels rub against, and which collects the electricity set free, and transmits it through their bearings to the two points, *i*, *i*, shown in the figures.

Instead of permanent magnets, the inventors prefer electro magnets. There remains always in the iron of these electro-magnets a little residuary magnetism sufficient to produce an induced current in the annular coil when the apparatus is put in motion. It is easy to see that the motion produces in its turn an induction current in the circuit of the electro-magnets in such a manner that these become excited more and more as the speed of the motion increases. When the apparatus assumes its normal condition of working, the electro magnets have acquired all their power, and continue to operate as magnets. So soon as the apparatus is put in motion, even at the most trifling speed, it produces a current visible by the least sensitive galvanometer. When the speed increases, the effects become more marked; the maximum appears to correspond to a speed of from 700 to 800 revolutions a minute, which is easily attained when the apparatus is driven by mechanical means.

We have seen, when the machine was driven by two men, a platinum wire 19½ in. long and nearly .0393 in. in diameter, heated to incandescence. Water can also be decomposed in a voltameter. Amongst other things there can be obtained by the machine all that can be produced with the battery. According to the special requirements, a short circuit of large wire, or a long circuit of fine wire, is employed.

We cannot judge at present of the practical qualities of the apparatus; but we believe from the simplicity of the apparatus, and the correctness of the principle, that it will play a very important part in the many branches of applied electricity.

BELGIAN COAL.—The exports of coal from Belgium are reviving. In April they amounted to 238,742 tons, against 302,781 tons in April, 1870. The aggregate exports to April 30, this year, were 775,952 tons, against 1,188,965 tons in the four corresponding months of 1870. Account must, of course, be taken of the exceptional circumstances which have prevailed.

THE SUEZ CANAL.—The receipts of this canal last year amounted in round figures to 256,000*l*. The balance remaining on hand on capital account at the close of last year was 832,000*l*., so that the total amount at the disposal of the company from all sources was 1,088,000*l*. The expenditure made and accruing during the year for supplementary works and the interest and redemption of loans amounted to 1,320,000*l*.; leaving a deficit for the year of about 240,000*l*. The receipts of the first five months of 1871 averaged 34,000*l*. per month, and it is expected that the revenue for the whole of 1871 will be about 400,000*l*., but the expenditure of the year on capital and revenue account combined is set down at 740,000*l*., so that a deficit of 340,000*l*. is probable. The deficits for 1870 and 1871 will thus amount together to 580,000*l*., and to cover them M. de Lesseps is endeavouring to negotiate a loan of 800,000*l*. In 1872 or 1873, he hopes that the canal will become self-supporting.

THE BRITISH ASSOCIATION.

FORTY-FIRST MEETING.

EDINBURGH, Wednesday.

THE forty-first meeting of the British Association is now being held in this city. The meeting of the General Committee was held at one o'clock, in one of the class-rooms of the University, Professor Huxley, F.R.S., the outgoing President, in the chair. After the transaction of the statutory business, reading reports, &c., extending over about an hour, the meeting terminated, and most of the members adjourned to the rooms set apart for the meetings of the various sections, in order to appoint their respective committees and arrange the order of business for to-morrow.

It should be mentioned that the meetings of all the sections will be held in the class-rooms of the College, a very convenient arrangement, and one which it is scarcely possible to get in any other than a University town. The Parliament House in High-street is set apart as the reception rooms, and certainly it affords the most ample and complete accommodation for all the purposes required. Together with the members present at the meeting of the General Committee, a glance through these rooms enables an old frequenter of these British Association meetings to form a sort of estimate of the prospective success of this year's meeting; that is to say, if numbers of well-known scientific men are to be any criterion to judge by. It certainly bids fair to be a good meeting.

The English lectures are to be held in the Music Hall, and there will also be a conversazione in the University, the invitations to which are given by the Principal and professors. Great preparations are being made to insure that there shall be abundant facilities provided for the pleasure, instruction, and social intercourse of the members of the Association. The excursions which are being arranged for will be held on Thursday, 10th August, after the proper business of the Association meeting is over. The botanists will go to Ben Ledi, beyond Callander, under the conductorship of Professor Balfour; Professor Wyville Thomson will superintend a dredging excursion in the Firth of Forth; while the geologists, under the guidance of Professor Geikie, will make a raid into East Lothian and Berwickshire. Other excursions will be made to Melrose, Dryburgh, and Abbotsford, and to Roslin and Penicuick, the last-named place being the head-quarters of the paper-making trade, which is of vast extent in the valley of the Esk, and within a short distance of Edinburgh. A considerable number of manufacturing and industrial establishments are to be thrown open to the members, including several large printing establishments, Messrs. Miller and Richard's type foundry, Messrs. John Gillon and Co.'s preserved provision factory, the Caledonian distillery and two breweries, Henry's gun-making works, engineering and shipbuilding works, glass works, Bonnington steam mills, &c. &c. Altogether, a very strenuous effort seems to have been made to give the British Association members a good reception.

Some good work will doubtless be done in the sections, as there are several reports to be read which will have a lasting interest on account of the results to which they will give rise. Subjoined we give the report of the Council.

Report of the Council for the year 1870-71, *presented to the General Committee at Edinburgh, on Wednesday, August* 2, 1871.

At each of their meetings during the past year, the Council have as usual received a report from the general treasurer, as

well as one from the Kew committee. A *résumé* of these reports will be laid before the general committee this day.

The Council have had under their consideration the several resolutions, five in number, referred to them by the general committee at Liverpool. They beg to report as follows upon the action they have taken in each case:—

First Resolution.—"That the discontinuance of the maintenance of Kew Observatory by the British Association having been determined on, the President and Council be authorised to communicate with the President and Council of the Royal Society, and with the Government, so that the future use of the buildings may in 1872 be placed at the disposal of the Royal Society, in case the Royal Society should desire it, under the same conditions as those buildings are at present held by the British Association."

A copy of this resolution was forwarded by direction of your Council to the President and Council of the Royal Society. The following is the reply which one of your general secretaries has received from Dr. Sharpey, secretary of the Royal Society:—

"The Royal Society, Burlington House,
July 8, 1871.

"DEAR DR. HIRST,—In reply to your letter of the 10th December, 1870, enclosing a copy of a resolution of the General Committee of the British Association relative to the future occupation of the buildings at Kew now held by the British Association, I am directed to acquaint you that the President and Council of the Royal Society are ready to take possession of the Observatory at Kew on the terms it is at present held from Her Majesty's Government, as stated in a letter dated 26th March, 1842, addressed to the President of the British Association from the office of Woods, &c., viz.: 'during the pleasure and upon the conditions usual on such occasions,—that no walls shall be broken through, and no alterations made that can affect the stability of the building, and alter its external appearance, without the previous sanction of the Board of Works.' I have further to acquaint you that the President and Council have appointed a Standing Committee of Fellows of the Royal Society for the management of the Kew Observatory in accordance with the terms of the Gassiot Trust, consisting of the following gentlemen: Mr. Warren De La Rue, Mr. Francis Galton, Mr. Gassiot, Admiral Richards, Sir Edward Sabine, Colonel Smythe, Mr. Spottiswoode, Sir Charles Wheatstone, and that 600*l.* from the income of the Gassiot Fund has been placed at the disposal of that Committee to meet the expenses of the establishment for the ensuing year.

"I remain, yours very truly,
(Signed) "W. SHARPEY, M.D.,
"Secretary, R.S."

Through the munificence of Mr. Gassiot, therefore, the Association can, without detriment to science, give up possession of the Kew Observatory at once instead of in 1872, as was originally contemplated. Your Council accordingly recommend that Government should be informed without further delay of the desire of the Association to see the direction and maintenance of the Kew Observatory transferred to the Royal Society.

Second Resolution.—"That the Council be empowered to co-operate with the Royal and Royal Astronomical Societies, in the event of a new application being made to Government, to aid in the observation of the solar eclipse of December, 1870."

On the 4th of November a joint committee of the Royal and Royal Astronomical Societies decided to make a second application; on the 5th of November your Council selected a few of their body to accompany the new deputation to Government which the above two societies had resolved to send. The necessity for any such deputation was subsequently obviated through the intervention of private individuals, and, as is well known, aid was promptly and liberally granted by Government to the Eclipse Expedition.

Third Resolution.—"That the Council be requested to take such steps as they deem wisest, in order to urge upon Government the importance of introducing scientific instruction into the elementary schools throughout the country."

A committee of your Council having considered the subject, recommended the appointment of a deputation to wait upon the Lord President of the Council in order to urge upon him the desirability of including elementary natural science amongst the subjects for which payments are made by the authority of the revised code. The Council accordingly formed themselves into a deputation, and on the 13th of December, 1870, had an interview with the Right Hon. W. E. Forster, M.P., Vice-President of the Committee of Council on Education, who was pleased to express his concurrence with the objects of the deputation, and his willingness to carry out those objects so far as circumstances would permit.

Fourth Resolution.—"That the Council of the British Association be authorised, if it should appear to be desirable, to urge upon Her Majesty's Government the expediency of proposing to the Legislature a measure to insure the introduction of the metric system of weights and measures for international purposes."

The Council deemed it expedient to postpone the consideration of this resolution.

Fifth Resolution.—"That it is inexpedient that new institutions, such as the proposed engineering college for India, should be established by Government, until the Royal Commission now holding an inquiry into the relation of the State to scientific instruction shall have issued their report, That the Council of the British Association be requested to consider this opinion, and, should they see fit, to urge it upon the attention of Her Majesty's Government."

The committee appointed without loss of time to consider and report on this resolution were informed at their first meeting that the arrangements for the establishment of the college had been virtually completed. Your president, however, in accordance with the wishes of this committee, entered into unofficial communication with the authorities at the India Office, relative to the proposed examination for entrance into the new Engineering College, and succeeded thereby in gaining for natural science, as compared with classics, a recognition, in the form of allotted marks, which it previously did not possess.

Your Council has given considerable attention to the important question (raised at the last meeting) of a revision of the regulations relating to the proceedings of the several sections at the annual meetings of the Association. Hitherto, it has been justly urged, these proceedings, from not having been sufficiently pre-arranged, have frequently been of too desultory and mixed a character. It is hoped that by proper observance of the revised regulations which are this day to be submitted to the general committee for approval, and by increased vigilance on the part of the sectional committees, much of this may be obviated, and that greater prominence may be given to, and a fuller discussion secured for, the really important communications which are annually made to the several sections.

The Council has pleasure in informing the general committee that the Association at length possesses a central office in London. The Asiatic Society has, in consideration of a yearly rent of 100*l.*, granted to the Association entire possession of four of their rooms at 22, Albemarle-street, and the use of another room for meetings of the Council and Committees. Your Council, moreover, acting under the power given to them by the general committee at Liverpool, have engaged Mr. Askham as clerk at a salary of 120*l.* a year. He is in attendance daily, and there transacts much of the business which was formerly done at the office of Messrs. Taylor and Francis, the printers to the Association. With the exception of certain works of reference, the whole of the books and MSS. formerly deposited at Kew, have been transferred to 22, Albemarle-street, and are being catalogued and rendered available for reference by members of the Association. One of the four rooms not at present in use, has been sub-let to the London Mathematical Society.

The Council having been informed by Dr. Hirst of his desire at the close of the present meeting to resign his office as joint general secretary of the Association, appointed a committee, consisting of the general officers and former general secretaries, to select a successor. This committee unanimously recommended the appointment of Captain Douglas Galton, C.B., F.R.S. The Council, entirely agreeing with the committee as to the high qualifications of Captain Galton for the office, cordially recommend his election by the general committee at their meeting on Monday next.

The Council cannot allow this occasion to pass without expressing their sense of the great services rendered to the Association by Dr. Hirst; but they abstain from saying more, as they are unwilling to anticipate a more mature expression on the part of the general committee.

The Council have added the following names of gentlemen present at the last meeting of the Association to the list of corresponding members:—Professor Van Benden, Dr. Crafts, Dr. Anton Dohrn, Governor Gilpin, Colorado; H. H. the Rajah of Kolapore, M. Plateau, and Professor Tchebichef.

The general committee will remember that Brighton has already been selected as the place of meeting next year. Invitations for subsequent meetings have been received by your Council, from Bradford, Belfast, Glasgow.

The Council, lastly, recommend that the name of Professor Balfour be added to the list of vice-presidents of the present meeting.

ADDRESS OF SIR WILLIAM THOMSON, KNT., LL.D., F.R.S., PRESIDENT.

For the third time of its forty years' history the British Association is assembled in the metropolis of Scotland. The origin of the Association is connected with Edinburgh in undying memory through the honoured names of Robison, Brewster, Forbes, and Johnston.

In this place, from this chair, twenty-one years ago, Sir David Brewster said:—"On the return of the British Association to the metropolis of Scotland I am naturally reminded of the small band of pilgrims who carried the seeds of this Institution into the more genial soil of our sister land." . . . . Sir John Robison, Professor Johnston, and Professor J. D. Forbes were the earliest friends and promoters of the British Association. They went to York to assist in its establishment, and they found there the very men who were qualified to foster and organise it. The Rev. Mr. Vernon Harcourt, whose name cannot be mentioned here without gratitude, had provided laws for its government, and, along with Mr. Phillips, the oldest and most valuable of our office-bearers, had made all those arrangements by which its success was insured. Headed by Sir Roderick Murchison, one of the very earliest and most active advocates of the Association, there assembled at York about 200 of the friends of science."

The statement I have read contains no allusion to the real origin of the British Association. This blank in my predecessor's historical sketch I am able to fill in from words written by himself twenty years earlier. Through the kindness of Professor Philips I am enabled to read to you part of a letter to him at York, written by David Brewster from Allerly by Melrose, on the 23rd of February, 1831:

"Dear Sir,—I have taken the liberty of writing you on a subject of considerable importance. It is proposed to establish a British Association of men of science similar to that which has existed for eight years in Germany, and which is now patronised by the most powerful Sovereigns of that part of Europe. The arrangements for the first meeting are in progress; and it is contemplated that it shall be held in York, as the most central city for the three kingdoms. My object in writing you at present is to beg that you would ascertain if York will furnish the accommodation necessary for so large a meeting (which may perhaps consist of above 100 individuals), if the Philosophical Society would enter zealously into the plan, and if the Mayor and influential persons in the town and in the vicinity would be likely to promote its objects. The principal object of the Society would be to make the cultivators of science acquainted with each other, to stimulate one another to new exertions, and to bring the objects of science more before the public eye, and to take measures for advancing its interests and accelerating its progress."

Of the little band of four pilgrims from Scotland to York, not one now survives. Of the seven first associates one more has gone over to the majority since the Association last met. Vernon Harcourt is no longer with us; but his influence remains, a beneficient and surely, therefore, never dying influence. He was a geologist and chemist, a large-hearted lover of science, and an unwearied worker for its advancement. Brewster was the founder of the British Association; Vernon Harcourt was its law-giver. His code remains to this day the law of the Association.

On the 11th of May last Sir John Herschel died in the 80th year of his age. The name of Herschel is a household word throughout Great Britain and Ireland—yes, and through the whole civilised world. We of this generation have, from our lessons of childhood upwards, learned to see in Herschel, father and son a *præsidium et dulce decus* of the precious treasure of British scientific fame. When geography, astronomy, and the use of the globes were still taught, even to poor children, as a pleasant and profitable sequel to "reading, writing, and arithmetic," which of us did not revere the great telescope of Sir William Herschel (one of the Hundred Wonders of the World), and learn with delight, directly or indirectly from the charming pages of Sir John Herschel's book, about the sun and his spots, and the fiery tornadoes sweeping over his surface, and about the planets, and Jupiter's belts, and Saturn's rings, and the fixed stars with their proper motions, and the double stars, and coloured stars, and the nebulæ discovered by the great telescope? Of Sir John Herschel it may indeed be said, *nil tetigit quod non ornavit*.

A monument to Faraday and a monument to Herschel, Britain must have. The nation will not be satisfied with any thing, however splendid, done by private subscription. A national monument, the more humble in point of expense the better, is required to satisfy that honourable pride with which a high-spirited nation cherishes the memory of its great men. But for the glory of Faraday or the glory of Herschel, is a monument wanted? No!

What needs my Shakespeare for his honoured bones
The labour of an age in piled stones?
Or that his hallowed reliques should be hid
Under a star-ypointing pyramid?
Dear son of memory, great heir of fame,
What need'st thou such weak witness of thy name!
Thou, in our wonder and astonishment,
Hast built thyself a live-long monument.
* * * *
And, so sepúlchred, in such pomp dost lie,
That kings for such a tomb would wish to die.

With regard to Sir John Herschel's scientific work, on the present occasion I can but refer briefly to a few points which seem to me salient in his physical and mathematical writings. First, I remark that he has put forward, most instructively and profitably to his readers, the general theory of periodicity in dynamics, and has urged the practical utilising of it, especially in meteorology, by the harmonic analysis. It is purely by an application of this principle and practical method, that the British Association's Committee on Tides has for the last four years been, and still is, working towards the solution of the grand problem proposed forty-eight years ago by Thomas Young in the following words:

"There is, indeed, little doubt that if we were provided with a sufficiently correct series of minutely accurate observations on the tides, made not merely with a view to the times of low and high water only, but rather to the heights at the intermediate times, we might form, by degrees, with the assistance of the theory contained in this article* only, almost as perfect a set of tables for the motions of the ocean as we have already obtained for those of the celestial bodies, which are the more immediate objects of the attention of the practical astronomer."

Sir John Herschel's discovery of a right or left-handed asymmetry in the outward form of crystals, such as quartz, which in their inner molecular structure possess the heliçoidal rotational property in reference to the plane of polarisation of light, is one of the notable points of meeting between Natural History and Natural Philosophy. His observations on "epipolic dispersion" gave Stokes the clue by which he was led to his great discovery of the change of periodic time experienced by light in falling on certain substances and being dispersively reflected from them. In respect to pure mathematics, Sir John Herschel did more, I believe, than any other man to introduce into Britain the powerful methods and the valuable notation of modern analysis. A remarkable mode of symbolism had freshly appeared, I believe, in the works of Laplace, and possibly of other French mathematicians; it certainly appeared in Fourier, but whether before or after Herschel's work I cannot say. With the French writers, however, this was rather a short method of writing formulæ than the analytical engine which it became in the hands of Herschel and British followers, especially Sylvester and Gregory (competitors with Green in the Cambridge Mathematical Tripos struggle of 1837), and Boole and Cayley. This method was greatly advanced by Gregory, who first gave to its working power a secure and philosophical foundation, and so prepared the way for the marvellous extension it has received from Boole, Sylvester, and Cayley, according to which symbols of operation become the subjects not merely of algebraic combination, but of differentiations and integrations, as if they were symbols expressing values of varying quantities. An even more marvellous development of this same idea of the separation of symbols (according to which Gregory separated the algebraic signs + and — from other symbols or quantities to be characterised by them, and dealt with them according to the laws of algebraic combination) received from Hamilton a most astonishing generalisation, by the invention actually of new laws of combination, and led him to his famous "Quaternions," of which he gave his earliest exposition to the Mathematical and Physical Section of this Association at its meeting in Cambridge, in the year 1845. Tait has taken up the subject of quaternions ably and zealously, and has carried it into physical science with a faith, shared by some of the most thoughtful mathematical naturalists of the day, that it is destined to become an engine of perhaps hitherto unimagined power for investigating and expressing results in Natural Philosophy. Of Herschel's gigantic work in astronomical observation I need say nothing. Doubtless a careful account of it will be given in the "Proceedings of the Royal Society of London" for the next anniversary meeting.

In the past year another representative man of British science is gone. Mathematics has had no steadier supporter for half a century than De Morgan. His great book on the differential calculus was, for the mathematical student of thirty years ago, a highly prized repository of all the best things that could be brought together under that title. I do not believe it is less valuable now; and if it is less valued, may this not be because it is too good for examination pur-

* Young's: written in 1823 for the Supplement to the "Encyclopædia Britannica."

poses, and because the modern student, labouring to win marks in the struggle for existence, must not suffer himself to be beguiled from the stern path of duty by any attractive beauties in the subject of his study?

One of the most valuable services to science which the British Association has performed has been the establishment, and the twenty-nine years' maintenance, of its observatory. The Royal Meteorological Observatory of Kew was built originally for a sovereign of England who was a zealous amateur of astronomy. George III. used continually to repair to it when any celestial phenomenon of peculiar interest was to be seen; and a manuscript book still exists filled with observations written into it by his own hand. After the building had been many years unused, it was granted, in the year 1842, by the Commissioners of Her Majesty's Woods and Forests, on application of Sir Edward Sabine, for the purpose of continuing observations (from which he had already deduced important results) regarding the vibration of a pendulum in various gases, and for the purpose of promoting pendulum observations in all parts of the world. The Government granted only the building—no funds for carrying on the work to be done in it. The Royal Society was unable to undertake the maintenance of such an observatory; but, happily for science, the zeal of individual Fellows of the Royal Society and members of the British Association gave the initial impulse, supplied the necessary initial funds, and recommended their new institution successfully to the fostering care of the British Association. The work of the Kew Observatory has, from the commencement, been conducted under the direction of a committee of the British Association; and annual grants from the funds of the Association have been made towards defraying its expenses up to the present time. To the initial object of pendulum research was added continuous observation of the phenomena of meteorology and terrestial magnetism, and the construction and verification of thermometers, barometers, and magnetometers designed for accurate measurement. The magnificent services which it has rendered to science are so well known that any statement of them which I could attempt on the present occasion would be superfluous. Their value is due in a great measure to the indefatigable zeal, and the great ability, of two Scotchmen, both from Edinburgh, who successively held the office of Superintendent of the Observatory of the British Association—Mr. Welsh for nine years, until his death in 1859, and Dr. Balfour Stewart from then until the present time. Fruits of their labours are to be found all through our volumes of Reports for these twenty-one years.

The institution now enters on a new stage of its existence. The noble liberality of a private benefactor, one who has laboured for its welfare with self-sacrificing devotion unintermittingly from within a few years of its creation, has given it a permanent independence, under the general management of a committee of the Royal Society. Mr. Gassiot's gift of 10,000*l.* secures the continuance at Kew of the regular operation of the self-recording instruments for observing the phenomena of terrestial magnetism and meteorology, without the necessity for further support from the British Association.

The success of the Kew Magnetic and Meteorological Observatory affords an example of the great gain to be earned for science by the foundation of physical observatories and laboratories for experimental research, to be conducted by qualified persons, whose duties should be, not teaching, but experimenting. Whether we look to the honour of England as a nation which ought always to be the foremost in promoting physical science, or to those vast economical advantages which must accrue from such establishments, we cannot but feel that experimental research ought to be made with us an object of national concern, and not left, as hitherto, exclusively to the private enterprise of self-sacrificing amateurs, and the necessarily inconsecutive action of our present Governmental departments and of casual committees. The Council of the Royal Society of Edinburgh has moved for this object in a memorial presented by them to the Royal Commission on scientific education and the advancement of science. The Continent of Europe is referred to for an example to be followed with advantage in this country, in the following words:

"On the Continent there exist certain institutions, fitted with instruments, apparatus, chemicals, and other appliances, which are meant to be, and which are made, available to men of science, to enable them, at a moderate cost, to pursue original researches."

This statement is fully corroborated by information, on good authority, which I have received from Germany, to the effect that in Prussia "every university, every polytechnical academy, every industrial school (Realschule and Gewerbeschule), most of the grammar schools, in a word, nearly all the schools superior in rank to the elementary schools of the common people, are supplied with chemical laboratories, and a collection of philosophical instruments and apparatus, access to which is most liberally granted by the directors of those schools, or the teachers of the respective disciplines, to any person qualified, for scientific experiments. In consequence, though there exist no particular institutions like those mentioned in the memorial, there will scarcely be found a town exceeding in number 5000 inhabitants but offers the possibility of scientific explorations at no other cost than reimbursement of the expense for the materials wasted in the experiments."

Further, with reference to a remark in the memorial to the effect that, in respect to the promotion of science, the British Government confines its action almost exclusively to scientific instruction, and fatally neglects the advancement of science, my informant tells me that, in Germany, "professors, preceptors, and teachers of secondary schools are engaged on account of their skilfulness in teaching; but professors of universities are never engaged unless they have already proved, by their own investigations, that they are to be relied upon for the advancement of science. Therefore every shilling spent for instruction in universities is at the same time profitable to the advancement of science."

The physical laboratories which have grown up in the Universities of Glasgow and Edinburgh, and in Owens College, Manchester, show the want felt of colleges of research; but they go but infinitesimally towards supplying it, being absolutely destitute of means, material or personal, for advancing science except at the expense of volunteers, or securing that volunteers shall be found to continue even such little work as at present is carried on.

The whole of Andrews's splendid work in Queen's College, Belfast, has been done under great difficulties and disadvantages, and at great personal sacrifices; and up to the present time there is not a student's physical laboratory in any one of the Queen's Colleges in Ireland—a want which surely ought not to remain unsupplied. Each of these institutions (the four Scotch Universities, the three Queen's Colleges, and Owens College, Manchester), requires two professors of natural philosophy—one who shall be responsible for the teaching, the other for the advancement of science by experiment. The University of Oxford has already established a physical laboratory. The munificence of its chancellor is about to supply the University of Cambridge with a splendid laboratory, to be constructed under the eye of Professor Clerk Maxwell. On this subject I shall say no more at present, but simply read a sentence which was spoken by Lord Milton in the first presidential address to the British Association, when it met at York in the year 1831: "In addition to other more direct benefits, these meetings [of the British Association], I hope, will be the means of impressing on the Government the conviction, that the love of scientific pursuits, and the means of pursuing them, are not confined to the metropolis; and I hope that when the Government is fully impressed with the knowledge of the great desire entertained to promote science in every part of the empire, they will see the necessity of affording it due encouragement, and of giving every proper stimulus to its advancement."

Besides abstracts of papers read, and discussions held, before the sections, the annual reports of the British Association contain a large mass of valuable matter of another class. It was an early practice of the Association, a practice that might well be further developed, to call occasionally for a special report on some particular branch of science from a man eminently qualified for the task. The reports received in compliance with these invitations have all done good service in their time, and they remain permanently useful as landmarks in the history of science. Some of them have led to vast practical results; others of a more abstract character are valuable to this day as powerful and instructive condensations and expositions of the branches of science to which they relate. I cannot better illustrate the two kinds of efficiency realised in this department of the Association's work than by referring to Cayley's Report on Abstract Dynamics* and Sabine's Report on Terrestrial Magnetism† (1838).

To the great value of the former, personal experience of benefit received enables me, and gratitude impels me to testify. In a few pages full of precious matter, the generalised dynamical equations of Lagrange, the great principle evolved from Maupertuis' "least action" by Hamilton, and the later developments and applications of the Hamiltonian principle by other authors are described by Cayley so suggestively that the reading of thousands of quarto pages of papers scattered through the *Transactions* of the various learned societies of Europe is rendered superfluous for any one who desires only the essence of these investigations, with no more of detail than is necessary for a thorough and practical understanding of the subject.

Sabine's report of 1838 concludes with the following sentence: "Viewed in itself and its various relations, the magnetism of the earth cannot be counted less than one of the most important branches of the physical history of the planet we inhabit; and we may feel quite assured that the completion of our knowledge of its distribution on the surface of the earth would be regarded by our contemporaries and by posterity as a fitting enterprise of a maritime people, and a worthy achievement of a nation which has ever sought to rank foremost in every arduous and honourable undertaking." An immediate result of this report was that the enterprise which it proposed was recommended to the Government by a joint committee of the British Association and the Royal Society with such success, that Captain James Ross was sent in command of the Erebus and Terror to make a magnetic survey of the Antarctic regions, and to plant on his way three magnetical and meteorological observatories, at St. Helena, the Cape, and Van Diemen's Land. A vast mass of precious observations, made chiefly on board ship, were brought home from this expedition. To deduce the desired results from them, it was necessary to eliminate the disturbance produced by the ship's magnetism; and Sabine asked his friend Archibald Smith to work out from Poisson's mathematical theory, then the only available guide, the formulæ required for the purpose. This voluntary task Smith executed skilfully and successfully. It was the beginning of a series of labours carried on with most remarkable practical tact, with thorough analytical skill, and with a rare extreme of disinterestedness, in the intervals of an arduous profession, for the purpose of perfecting and simplifying the correction of the mariner's compass—a problem which had become one of vital importance for navigation, on account of the introduction of iron ships. Edition after edition of the "Admiralty Compass Manual" has been produced by the able superintendent of the Compass Department, Captain Evans, containing chapters of mathematical investigation and formulæ by Smith, on which depend wholly the practical analysis of compass-observations, and rules for the safe use of the compass in navigation. I firmly believe that it is to the thoroughly scientific method thus adopted by the Admiralty, that no iron ship of Her Majesty's Navy has ever been lost through errors of the compass. The "British Admiralty Compass Manual" is adopted as a guide by all the navies of the world. It has been translated into Russian, German, and Portuguese; and it is at present being translated into French. The British Association may be gratified to know that the possibility of navigating ironclad war ships with safety depends on application of scientific principles given to the world by three mathematicians, Poisson, Airy, and Archibald Smith.

(*To be continued.*)

* Report on the "Recent Progress of Theoretical Dynamics," by A. Cayley (Report of the British Association, 1857, p. 1).

† Report on the "Variations of the Magnetic Intensity observed at different points of the Earth's Surface," by Major Sabine, F.R.S. (forming part of the 7th Report of the British Association).

TREDGOLD'S CARPENTRY.

TO THE EDITOR OF ENGINEERING.

SIR,—We do not willingly rest under the imputation of misstatement. We are, indeed, astounded at Messrs. Spon's statement that the edition of "Tredgold" used by Mr. Hurst was that of 1820. We took the plain statement in his preface: "A considerable time having elapsed since the publication of the second edition (1820), a new edition was much required. . . . In order to adapt this work as far as possible," &c., &c. If the first edition was used, why make this express mention of the second edition as the starting point and why not use the words "first edition" on the title-page, instead of the vague words "original edition"? Assuming, Messrs. Spon's statement to be true, the "many important additions and improvements" made in the second edition (*vide* author's advertisement) find no place in Mr. Hurst's book.

Messrs. Spon's arithmetic seems curiously at fault when they say that the 1820 edition was out of copyright twenty-two years, when it is notorious that copyright runs for forty-two years. This does not affect the principle.

As to Messrs. Spon's statement that "the proceeding is generally practised in the publishing trade, and is" (by which we presume they mean is recognised as) "fair and honourable," we refer you to the fact that your contemporary, the *Publisher's Circular*, which may be supposed to know something of the usages of the trade, extracts, in its issue of the 1st instant, a portion of our letter from your columns, evidently regarding the transaction as an unusual and remarkable one in the legitimate publishing trade. We do not deny that there is a class in the trade who adopt these practices, and of course Messrs. Spon are quite at liberty to enrol themselves in its ranks.

It is ridiculous in Messrs. Spon to accuse us of unfairly confounding their book with Barlow's edition, when it is obviously and expressly our endeavour to caution the public against so confounding them.

If, as Messrs. Spon acknowledge, their book is "more the work of Mr. Hurst than of Mr. Tredgold," why do they persist in advertising and entitling it "Tredgold's Principles of Carpentry"?

We remain, Sir, yours respectfully,

LOCKWOOD AND CO.

7, Stationers' Hall-court, August 2, 1871.

[We can admit no further correspondence on this subject.—ED. E.]

FRENCH SCIENTIFIC PERIODICALS.

Nouvelles Annales de la Construction.
Portefeuille Economique des Machines.

TO THE EDITOR OF ENGINEERING.

SIR,—May I ask for space in your journal to make the announcement that the *Annales de la Construction* and the *Portfeuille des Machines* have been completed and published for the years 1870 and 1871, in spite of the war and the two sieges of Paris. The numbers of these journals published during this period contain, amongst other matters, the barracks of the National Guard and the Mobile Guard in Paris, the postal balloons employed during the siege, complete studies on the Chassepôt gun, on the breechloading field gun, the Gatling gun, the Christopher and Montigny French mitrailleuses, the mills erected in Paris for the food supply during the investment, the stables and depôts of Grenelle, the great Luxembourg ambulance, besides a great number of other interesting subjects, such as the new Paris opera house, the agricultural and convict colonies, house lifts, &c. I am, dear Sir, yours very truly,

C. A. OPPERMANN.

BIRMINGHAM TRAMWAYS.—The prospectus of the Birmingham and District Tramways Company is announced, with a capital of 130,000*l.*, with the object of constructing various lines in and about Birmingham.

SOCIETY OF ENGINEERS.—Arrangements have been made for a visit of the members and associates of this Society to the Pumping Station, Abbey Mills, West Ham, Stratford; to the Telegraph Works, North Woolwich; and to the Lodge Farm, Barking, on Monday the 7th of August, 1871. Members and associates to meet at Bow Railway Station, at 11 o'clock a.m.

BUTLER'S STONE CAISSONS.—In the course of an article upon stone caissons, published a few weeks since, we stated that the caissons manufactured by Mr. Frederick Ransome, under Mr. Butler's patent, and inspected recently by a party of engineers at the Ransome Stone Works, Greenwich, were about to be employed in the construction of the Hermitage Wharf. Since the date of writing that article the cylinders in question have been placed in position with perfect success. The cutting edges of the bottom rings were unprotected by iron shoes, such as would be employed when the ground through which they were forced would render such protection necessary. The depth to which these cylinders have been sunk is 21 ft. below the bed of the river, and it is found that the joints between the rings remain perfectly tight and reliable. So far then all that we have advanced in favour of this new application of a new material has been more than borne out by practice; and with care in construction and subsequent sinking we believe that there is a very large field for their application.

KIRK'S REFRIGERATING MACHINE.

CONSTRUCTED BY MESSRS. JOHN NORMAN AND CO., ENGINEERS, GLASGOW.

(*For Description, see opposite Page.*)

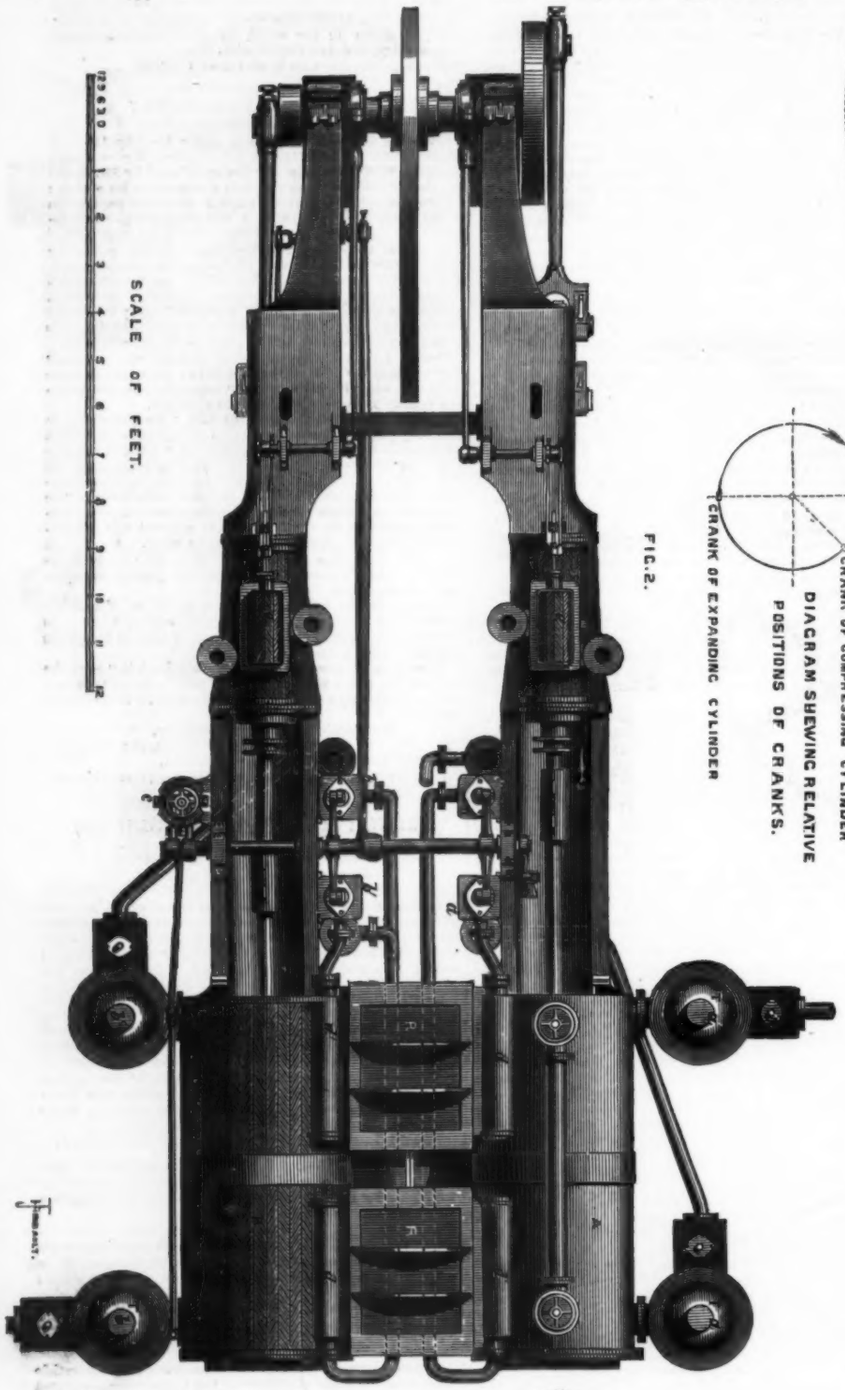


FIG. 2.

DIAGRAM SHEWING RELATIVE POSITIONS OF CRANKS.

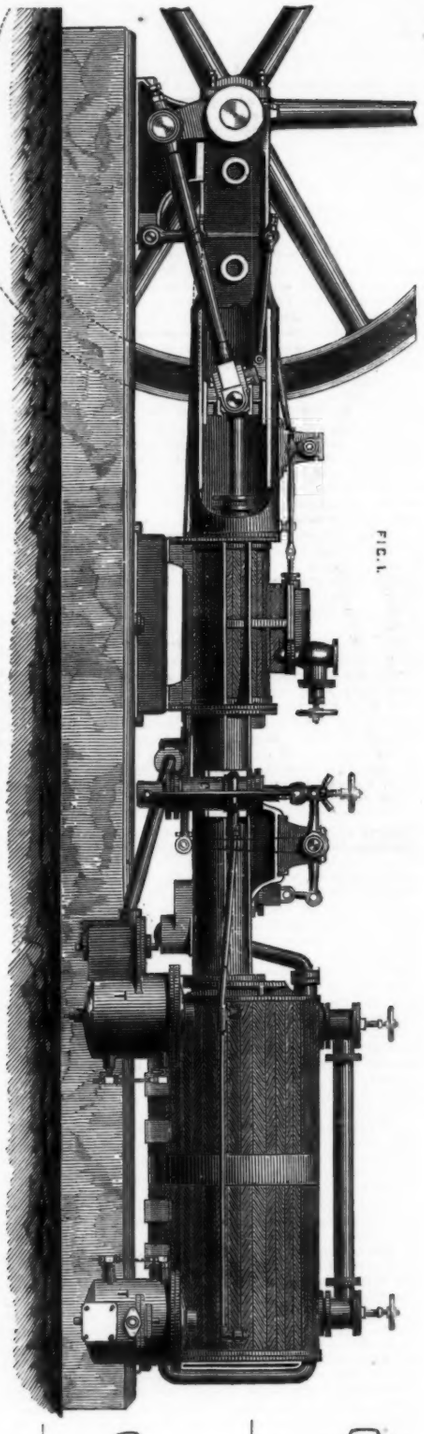
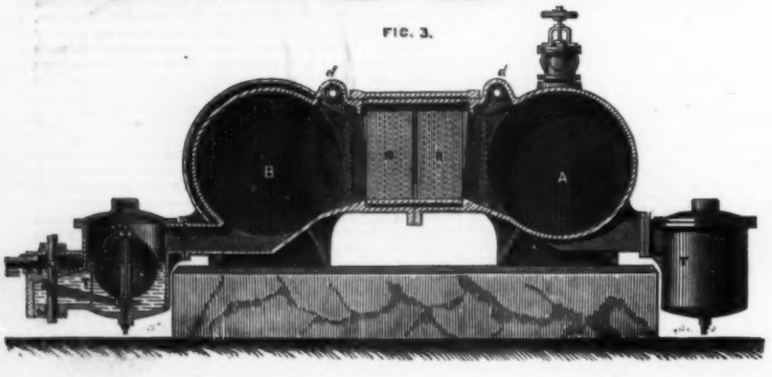
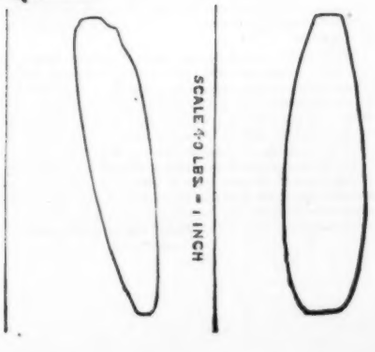


FIG. 1.

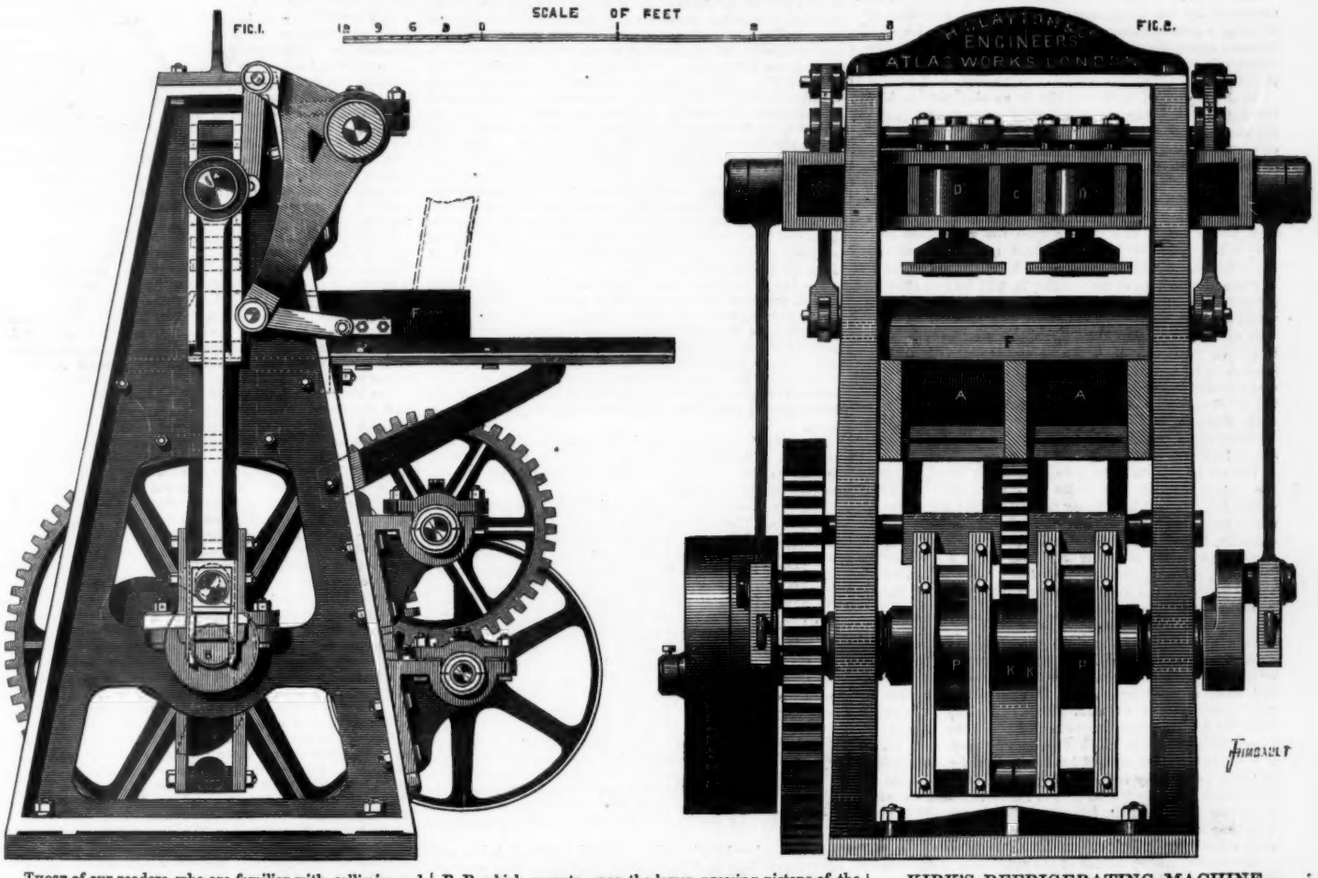
FIG. 3.





PRESS FOR FORMING BLOCKS OF DUST COAL.

CONSTRUCTED BY MESSRS. HENRY CLAYTON, SON, AND HOWLETT, ENGINEERS, LONDON.



THOSE of our readers who are familiar with collieries and coal depôts will be well aware that an invariable feature in each and all of them is the large heaps of small coal siftings which in that state are hardly worth the cost of cartage. By the employment of suitable machinery and by proper manipulation, this débris may be economically converted into blocks of regular dimensions, and uniform weight, which commands at once a fair market value. In proof of this we may mention that immense quantities of this fuel are at present exported from various parts of England to all quarters of the globe. It is valued for its excellent heating properties, for the facility with which it may be handled and stored, and for its moderate price as compared with ordinary coal. To produce the necessary adhesion of the particles a glutinous medium is employed for admixture with the coal dust, and a vast number of patents have been obtained for certain compositions more or less effectual for this portion of the manufacture. Coal, tar, pitch, starch, clays, &c., in many cases combined with various chemical compounds, are most commonly employed in practice, and the fuel so manufactured has earned a satisfactory reputation. It is much used abroad, principally in France, Italy, and India, for generating steam in engine boilers, as well as for domestic purposes.

The machinery specially applicable to the manufacture of this class of artificial fuel consists of the preparatory apparatus, first, for screening the coal and for mixing the smalls with its glutinous constituents, and for bringing it into a consistency suitable for pressing. This machinery varies in its construction according to the nature of the medium employed, and is more or less well known. The materials having been sufficiently prepared and thoroughly incorporated, are next fed to a press in which the composition is moulded into blocks for the market. In the accompanying engraving we illustrate an apparatus for this purpose, which has recently been introduced by its designers and manufacturers, Messrs. Clayton, Son, and Howlett, of the Atlas Works, Woodfield-road, Harrow-road. This machine—of which Fig. 1 is a side, and Fig. 2 a front elevation—consists of two cast-iron side frames, between which is fixed a horizontal bed in which are formed the pressing moulds, A, A, which are the size of the blocks intended to be produced. Upon this bed there works a reciprocating measure feeder, F, capable of containing a sufficient quantity of material for each charging of the moulds. This feeder receives the prepared coal from a mixing cylinder shown by dotted lines in Fig. 1, under which it works. Motion is given to it by means of the cranked levers connected to the main crosshead of the machine.

Pressure is given both at top and bottom of the blocks, B is a wrought shaft situated beneath the moulds and driven through compound gearing. It is constructed with cams, P, P, which operate upon the lower pressing-pistons of the machine. At each extremity of this lower shaft is affixed a crank. These cranks are connected to an overhead crosshead, C, by strong coupling rods. The crosshead works in guides in the side frames, and to it are attached the upper pistons of the machine. These last are connected with stiff springs arranged in glands as shown at D, D, in order to prevent any undue strain that might occur affecting the other parts of the machine. From the engraving it will be observed that, the mould being filled, the top pistons descend into the mould at the same time as the lower pistons in their revolution commence an upward pressure. The top pistons now rise and the lower ones are further raised so as to bring the blocks flush with the bed, A, when they are pushed from their position by the measure feeder, F, which approaches with a fresh charge of material. The lower pistons are immediately acted upon by the cams, K, K, reversely arranged to the pressing cams P, P, and are caused to descend so as to leave the moulds ready for reception of the material brought by the feeder.

An engine of 2-horse power is quite sufficient to drive this machine which will turn out 10,000 blocks of about 5 lb. weight each per day, giving an average of about 20 tons per day. The apparatus occupies but a small amount of space, its dimensions being about 5 ft. by 4 ft. by 6 ft. high. It may be mentioned that a great feature in the machine is, that the framework is relieved from the pressing strain which is supported by the two side arms which are made of proportionate strength. The under pistons are constructed with a chamber packed with wool, which is charged with oil, so that in their movement up and down they lubricate the moulds.

A MONSTER AMERICAN RAILWAY DEPÔT.—The Union Railroad Depôt of the New York Central River, the New York and Harlem, and the New York and New Haven Railroads, just completed in New York city, covers an immense parallelogram, extending from Forty-second-street to Forty-fifth-street; and it is 692 ft. long and 240 ft. wide. The building is constructed in the Renaissance style, and the materials employed are smooth red brick and iron painted white. The centre of the façade in Forty-second-street, or on the south side, presents a tower 130 ft. high with towers 110 ft. high at each corner. The façade on the west side presents three towers 110 ft. high. The north side is constructed entirely of iron, and has ten high iron arches for the passage of trains. The building, which is 40 ft. deep on each front for the offices and waiting rooms, is three stories high. In the interior is a central space 650 ft. by 200 ft., covered with a roof formed of glass and corrugated iron, and supported by thirty-one semi-circular iron trusses 4 ft. wide and 1 ft. thick.

KIRK'S REFRIGERATING MACHINE.

ABOUT five and a half years ago (*vide* pages 62 and 124 of our first volume) we published in this journal an account of an ice-making machine, designed by Mr. Alexander C. Kirk, of Glasgow, in which the desired refrigerating effect was obtained by compressing air, cooling it when in a state of compression, and then allowing it to re-expand when it, of course, absorbed heat from the surfaces with which it was in contact. The success of this apparatus led to Mr. Kirk receiving frequent inquiries from brewers regarding the application of his atmospheric ice-making machine to the purpose of cooling water without making ice, and considering it unnecessarily elaborate for that purpose he commenced a series of experiments about two years ago with the view of producing a simpler machine than is required for ice making, but still using atmospheric air as the cooling medium. These experiments have resulted in the manufacture of a large machine capable of cooling 45 barrels of water 15 deg. per hour, and of this machine we give engravings on the opposite page.

As in the ice-making machine, the principle is that a certain quantity of air contained in the machine is alternately expanded and compressed, the compression and expansion being performed in separate chambers, and the air, while being transferred from one to the other, being passed through a regenerator. Instead, however, of the heat being removed from the air during compression by a metallic surface kept cool by a current of water, and being imparted to it during expansion by a similar surface, warmed by a current of the fluid to be cooled, the water employed to remove the heat of compression, and that which is to be cooled by expansion are injected as a shower into the hot and cold chambers among the compressed and expanded air, and allowed to flow out through a simple arrangement of valves. Thus it is not necessary to use dry air, which is also a simplification. As in the ice-making machine the "working air" may be above the atmospheric density, and in the machine shown the ratio of expansion is from about 35 lb. per square inch to 17 lb. The machine we illustrate is double-acting, and it will thus suffice to confine our attention to the operations carried on at one end of each cylinder.

The part of the machine which forms the cooling apparatus consists of the cylinders, A and B, with their connections, and the motive power consists of two steam cylinders with their usual connecting rods, crank shaft, and fly-wheel. In the engraving ordinary non-condensing engines

are shown; but these machines are now being made, driven by compound engines with surface condenser, the latter enabling clean water for washing, &c., to be heated by the exhaust steam.

The cylinders A and B are each closed at each end, and connected by the large square passages, R, R, which are filled by a great number of thin brass plates placed a small distance apart, between which there is thus a free communication for the air to pass to and fro from one cylinder to the other.

At the middle of each cylinder is an air tight packing, through which works a double-acting plunger, attached to the piston rods, connecting rods, and cranks, by the position of which, shown in a separate diagram, the relative motion of the plungers is governed. T T T T are traps containing each a copper float and valve, by which the outflow of the water is regulated; $a p$, $a p_1$, $b p$, $b p_1$, are double acting pumps, pumping water into the four ends of the two cylinders, where it falls in a shower from the perforated pipes, d d; e is a pump for forcing a small quantity of air into the cylinders, A and B, to make up loss by leakage, &c.

From the position of the cranks, it will be seen that the air contained at the back of cylinder A is first compressed while the plunger at the back end of B is nearly stationary, that as the crank moves round, and the plunger of B begins to recede, while that of A moves on, the air is transferred from A to B, and when the plunger of A is nearly stationary on its centre at the back end, the plunger of B moving on the air contained in B, is now allowed to expand. When both plungers begin again to move, the expanded air is transferred to cylinder A, again compressed, again transferred to B, again expanded, and so on.

The air in passing from A to B, and *vice versâ*, traverses the spaces between the plates of the regenerator, which completely prevent heat being carried by the air from the compressing, or hot cylinder, A, to the expanding, or cold cylinder, B. The air also on each side of the regenerator traverses a shower of water kept constantly flowing by the pumps, p_1 p_1 p_1 p_1, that on the hot side being heated by the compressed air, and that on the cold side cooled by the expanding air.

The water pumps are thus arranged: a_1 p draws the water required to cool the air from the well, and pumps into back of cylinder, A, at d_1, from which its escape is regulated by trap, a_1. Pump, $a p$, draws from trap, a, and pumps into front of cylinder, A, at d, from which it escapes by trap, a, being twice warmed. Similarly pump, b_1 p, draws from the well the water to be cooled and forces it into cylinder, B, at d_1, from which it escapes by trap, b_1. Pump, b p, draws from trap, b_1, and forces into cylinder, B at d, from which it escapes by trap, b, being twice cooled. This arrangement was adopted, as it was found that the air acted more perfectly when the full current of water was exposed to it than if—as when first tried—one half was pumped into each end of the cylinders.

The smoothness of motion of the machine is remarkable, it working without noise or jar, and this is fully accounted for, as each plunger works in an elastic cushion of air, and there are no moving parts such as valves. Indeed, inside the cooling part of the machine the only moving parts are the large plungers. The packing of the plungers being an hydraulic leather packing, shows no signs of wear, and requires no attention.

Fig. 5 shows two diagrams—one from cylinder A and one from cylinder B; the difference of these is the power spent. In conclusion we should state that this machine, which is distinguished alike by its simplicity and ingenuity, is being constructed, according to Mr. Kirk's designs, by Messrs. John Norman and Co., of Glasgow.

THE ST. CHARLES BRIDGE.

WE illustrate on page 74, a railway bridge recently constructed over the Missouri River, for the accommodation of the North Missouri Railway, by the St. Charles Bridge Company, by which it has been leased to the railroad company at an annual rental of 100,000 dols. The cost of the bridge has been 1,800,000 dols., or nearly double the original estimate, this excess arising from the difficulties encountered in constructing the foundations.

Its construction has occupied nearly three years, having been commenced in August, 1868, and practically completed on the 23rd of May, 1871. It is the longest iron bridge in the United States, consisting of three "through spans" on the Fink plan, four "Fink suspension" spans and the iron viaduct approaches, making a total length of iron bridge of 6535 ft. The seven river spans vary in length from 305 ft. to 321 ft. There were eight river foundations—most of them presenting new and extraordinary difficulties in construction—varying from 54 to 76 ft. in depth, the caissons for which had to be carried down through alternate strata of quicksand, large boulders, and tangled masses of drift logs. Add to these subaqueous difficulties the facts that at the bridge site the Missouri River rises and falls 40 ft.; that its flood speed is nine and one-half miles per hour; and that drift islands drawing 20 ft. of water, and which are more than 300 ft. in diameter, are not unfrequently carried past in the heavier freshets, and an adequate idea may be formed of the character of the work.

During the progress of the work, owing to an unusual freshet, the general direction of the current was suddenly changed. Four thousand feet above the site of the bridge a diversion of the current carried away 1400 ft. of the south bank, and, curving outward and returning in the form of an S, brought its abraiding force directly upon the south abutment. In this emergency, when the entire demolition of the abutment was threatened, the engineer constructed a groyne which so diverted the current as to reclaim a large tract from the river bed and confine the channel. The south abutment is now surrounded by dry land. This groyne projects 700 ft. from the south shore, and extending above the shore some 400 ft. Out from the south shore a "pile wall" was driven, from which coarse riprap was thrown in, and an embankment made upon it, producing an eddy immediately below. In this eddy, material could be deposited without danger of wash, and so the work was carried forward in an irregular line, guided by the slack-water which preceded the bank in its progress down stream. This was continued until a space 700 × 400 ft., more or less, was enclosed by the wall meeting the shore below the bridge line. After being properly packed and protected from wash, this immense coffer-dam, for such it now was, was pumped out, leaving the former uncertain bed of the river comparatively dry land upon which the pier could be erected without interference from the principal enemy, the river current. It was afterward built to such a height and so strengthened that its outer walls now form the south bank of the river at that point, thus effectually and permanently forcing the current to keep toward the north shore and to be confined within fixed limits. Although the cross section of the river is necessarily narrowed, it does not effect the velocity of the current.

The bed of boulders found immediately below the shifting bottom, although more permanent in position, by their bulky and unyielding nature made the passage of the foundations through them very difficult. To drive a pile through them required an average of 3000 blows of a 3000 lb. hammer, and, in some cases, over 5000 blows were required to sink the pile to the bed rock. Sycamore piles alone were found capable of standing the continued batter of the pile hammer. The pile basis was used only when the pile was entirely protected from scour.

Piers No. 1 and 2 developed few novelties in their construction. Pier No. 2 was sunk 6 ft. into the solid rock, making its base as stable as—and, indeed, a part of—the stratum in which it rests.

Pier No. 3.—This foundation is in 23 ft. of water, at ordinary stage. The current is very swift, and the bottom is apparently solid rock. A wooden caisson, without floor, was sunk on the site, bolted to the rock, and a submarine wall, composed of large boxes filled with beton, built around it at a distance of 6 ft. from the caisson, and the intervening space was puddled with concrete. The caisson was then pumped out; but, before the bed was laid bare, the rock bottom blew up revealing the fact that the caission rested on an imperfect ledge of limestone, below which was a decomposed seam. The bottom was then excavated by divers until solid rock was reached. The crater was filled with concrete and two courses of stone laid upon it. The foundation was then ready for pumping out, but at this juncture the river rose 26 ft., and, although another section was added to the caisson, the water finally drove the drift-men from their work, and the drift accumulated to such an extent that the caisson was completely crushed and piled in a mass of wreck over the foundation. On the subsidence of the river the wreck was cleared away, and the foundation proving uninjured, the pier was built in a caisson boat and sunk on the spot.

Pier No. 4.—At this point the rock lay 54 ft. below ordinary water stage and there was a varying depth of sand and boulders of from 11 ft. to 53 ft. At the time of the flood of 1869 all the piles were driven for the breakwater, and these soon collected a mass of drift covering more than an acre, and drawing from 25 to 30 ft. of water. This caused a deep hole to be scoured, and into it the boulders, moving with the sand wave, rolled, and, failing to mount the slope of the further side, they remained in the excavation and were soon afterwards covered with the pile wreck—the whole of which having been crushed down flat on the boulder-bed by the pressure of the drift. When the drift was released the scour stopped, and the crater was filled with gravel by the action of the river.

It was through this tangled mass of drift and boulders that the foundation was afterwards carried. A double-walled caisson, with the interspaces between the walls filled with stone, was sunk by dredging to the solid rock. The work was tedious and difficult; four heavy water jets were kept running day and night, and all small boulders and gravel were fed to the dredgers by this means. Where the boulders were too large, or to tightly packed for this, they were moved with crowbars by the divers, and if of more than half a ton in weight, were hoisted out by the derricks. When the rock was finally reached, it was cleared off, and 12 ft. of concrete laid, then two courses of stone, and then the pier was lowered to its place by means of screws.

Pier No. 5.—Here the rock was 68 ft. from the surface, and the rise and fall of the sand wave, 32 ft. The compressed air system was used in the sinking, combined with the "Eads sand pump" and a peculiar boulder shaft, designed for this pier. One air lock was of the usual character, but placed at the foot of the shaft, and through this lock all the supply pipes, as well as the persons engaged in the cassion, passed. The other, or boulder lock, was also at the foot of the shaft, but was 10 ft. deep, and the air was so arranged that the changes were made too rapidly to be endured by the human frame, and, consequently, workmen were not permitted to pass through it. Two large doors opened into the chamber from this lock, and the iron boulder cars were pushed in through them, the doors closed, the air change made, the trap in the shaft dropped, and the cars were lifted out by the steam derrick overhead, and the boulders swung out over a barge, where the cars were tipped and emptied. This entire operation occupied less than three minutes.

Piers 6, 7, and 8 are all alike in the character of their foundations. First a circle of "tub piles" was driven, inside of these a caisson was sunk some 30 ft. by dredging, and the circular crater outside of the tub-piles was filled with stone as the caisson sank. This process was kept up until stone from the crater began to appear in the dredger buckets, showing that the ring of riprap had begun to pass beneath the tub-piles. When this took place the dredges were removed, the piles were driven down to the rock, cut off at the level of the bottom of the caisson, and the pier was lowered on to the pile heads by means of screws. The caisson was then filled with stone and the work was complete. These piers are 151 ft. from the base of the piles to the top of the masonry. From the base of the pier No. 5 to the top of the truss is 186 ft.

The superstructure is of the Fink and trellis or double form, the latter modified by the omission of the usual counter ties. The counter strains are taken by compression ties, extending a few panels on each side of the centre, and consisting of two parallel plates stiffened by short diagonal braces of wrought iron rivetted to the side plates, and at the centres. The wrought-iron strut columns are secured to the chord by wrought-iron suspension joints, so that they are equally available for tensile strains at points where such strains occur, thus dispensing with the centre tie-rod usually found in this form of truss. The substitution of the peculiar ties at the centre for counter ties constitutes the essential diference between this truss and the one used at Kansas City.

The details show many important features of novelty. A leading idea of the engineer has been to construct the bridge of as few pieces as possible. For instance, the upper chord is composed of a single cast-iron tube. The structure is fastened throughout by pin joints. The cross ties are placed directly upon rolled iron girders placed between the chords proper, thus throwing all the bending strains upon parts not subject to either tension or compression, dispensing with the ordinary stringers and avoiding the bulky depth of flooring beams usually seen.

The Fink deck spans are proportioned to carry 2250 lb. per foot, the chord is 2 ft. in diameter, and the main post 21 in.

The truss itself is a "double triangular girder," with inclined end posts, and no connexion between the systems. The counter brace action is secured by stiffening the middle ties and giving the braces a tensile connexion. The floor beams are composed of 12-in. channel iron, sandwiched with and forming part of the lower chord, the cross ties being laid directly on these, without the interposition of a stringer.

These girders are proportioned in the same manner as in the Fink trusses, but to a working load of 2400 lb. per foot. The weight of each Fink span is 680,000 lb.; of each trellis span 788,000 lb.

Probably the most dangerous work of all was the erection of these spans. As no false work could possibly stand at this point in the river, temporary piers were constructed, resting on piles, and surrounded by cribs 18 ft. wide and 50 ft. long, filled with stone. There were three of these piers in each span, and on these were placed, bodily, by means of powerful twin derrick boats, Howe truss spans, 80 feet each. On these spans was placed the false work proper, the top of which was 121 ft. from the water.

During the winter of 1870-71, No. 1 was swung, at noon, on a day when the break of the ice gorge above above was imminent. Fearing this, the Howe trusses and their superincumbent false work were bolted up to the span. During the night the ice went out, wrecking the crib piers beneath, but leaving the whole mass of false work, including the Howe trusses, hanging from the span which one day before they had been carrying. The bridge is owned by the St. Charles Bridge Company, and was designed and constructed by Mr. C. Shalor Smith. Captain James B. Eads, the engineer of the great St. Louis Bridge, is one of the leading directors in the company. We are indebted to the Chicago *Railway Gazette* for the information contained in the foregoing description.

NOTES FROM THE SOUTH-WEST.

Cardiff Tramways.—A provisional order made by the Board of Trade for the construction of tramways in Cardiff, is proposed to be confirmed by a Bill introduced into Parliament. The promoters of the scheme are to be known as the Cardiff Tramways Company (Limited). The tramways are to be laid in granite pitching, and they are to be always kept on a level with the surface of the roads. No interference will be allowed with the traffic of the Taff Vale Railway Company at the level crossing in Bate-street, and the company will always have precedence of the tramways. The tramways are to be used exclusively for passenger traffic, and the charge is not to exceed 1d. per mile, excepting in cases in which the distance travelled is less than a mile when the charge may be 2d. A cheap rate of a ½d. per mile for artisans, mechanics, and daily labourers, is to be enforced, two carriages being required to run each way morning and evening at that rate.

The Proposed Tunnel under the Severn.—Mr. C. Richardson, C.E., and Mr. Leonard Bruton, have waited as a deputation upon the Newport Chamber of Commerce; and after explaining Mr. Richardson's project for a direct communication between Bristol and South Wales by means of a tunnel under the Severn, they asked the chamber to pass a resolution approving of the scheme. It was, however, deemed advisable to postpone a discussion of the subject until further information was obtained upon the question.

Gloucestershire Railway Enterprise.—It is said that in the next session of Parliament three plans will be proposed for crossing the Severn and uniting the railway systems east and west of the estuary. Two of these plans contemplate tunnels, and the engineers who bring them forward are Mr. Richardson and Mr. Fulton. The third is a revival of the Gatcombe bridge scheme under the auspices of a company to be called the Western Junctions Company. It is proposed to erect a composite bridge for railway and general traffic to be connected with the Severn and Wye, the Forest Central, and the South Wales, on the western shore, and by a new line running from the new docks at Holly Hazel Pill to the Midland at Thornbury, and the Bristol and South Wales line near Almondsbury; it is also proposed to carry out a short connecting line from the Midland to the Great Western at Stonehouse.

Bristol and South Wales Railway Wagon Company (Limited).—The directors of this company recommend a

dividend at the rate of 10 per cent. per annum, after making the usual addition to the reserve fund for depreciation, &c. The company seems a sound and prosperous concern.

Trade at Newport.—At the last South Wales and West of England coal and metal market at Newport, pig iron remained firm at former quotations, and the best brands were difficult to obtain. Refined tin continued firm at the high prices recently obtained. A quantity of Irish aluminous ore was on offer.

South Wales and West of England Coal and Metal Markets.—A market was held at Swansea on Saturday. The general trade of the district was reported on favourably, but the business transacted was compartively unimportant.

The Forest of Dean.—A strike at Wimberry collieries terminated on Monday. The men appear to have gone in at their former rate of wages.

Taunton Gas Company.—This company has declared a dividend at the rate of 7 per cent. per annum.

Treforest Tin Works.—The millmen at the Treforest Tin Works gave notice to leave a day or two since on a decision of the company being made known to them to the effect that they were to work only eight hours instead of twelve hours per day. The millmen contend that they endure sufficient loss of time already on account of the insufficiency of water during the summer months to work the machinery.

East Gloucestershire Railway.—The works on this line are, it is said, being rapidly proceeded with by Mr. W. Dixon, the contractor. It is expected that the whole section between Whitney and Fairford will be completed early next spring.

A Dry Dock for Milford.—A new dry dock is expected to be commenced shortly at Milford. It is designed for the accommodation of the Great Eastern.

Taff Vale Railway.—The traffic of this line continues to be much affected by the strike among the steam coal colliers of South Wales. The working expenses have, however, been much reduced, and there are signs that the great strike is coming to an end. The iron works in the neighbourhood of Cardiff are working with their usual regularity.

Spiegeleisen.—Spiegeleisen continues to be successfully produced by the Ebbw Vale Steel, Coal, and Iron Company (Limited). It will be remembered that spiegeleisen plays a very important part in the manufacture of steel under the Bessemer process.

Railway Iron for the United States.—The demand for railway iron for the United States continues good. Fresh orders come to hand by almost every mail. Bessemer steel rails continue in great request.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The pig iron market has not been so brisk for several days, but to-day there has been a re-action with much firmer tone. On Monday 60s. 9d. seven days, to 60s. 6d. prompt, and 61s. to 60s. 10d. one month were the prevailing prices; to-day, however, there were higher prices asked and obtained. The shipments continue to be very large. South Wales is again making demands upon the Scotch market in addition to France, Germany, and America.

Consulting Engineer for the Tay Bridge.—At a meeting of the Works Committee of the Dundee Harbour Trustees, a letter was read from the North British Railway Company, asking the Trustees to nominate an engineer to act on their behalf in regard to the works to be executed at the harbour in connexion with the line through Dundee to the Tay Bridge. The meeting agreed to appoint Mr. Harrison as their engineer.

Mineral Oil for Lighthouse Illumination.—Mr. M'Lagan M.P. for Linlithgowshire, has given notice that in Supply on the Civil Service Estimates he will call the attention of the House to correspondence between the General Lighthouse authorities and the Board of Trade relative to proposals to substitute mineral oils for Colza oil in lighthouses, and to move "That it is expedient to substitute mineral oils for Colza oil in the lighthouses on the coasts of England, Scotland, and Ireland, seeing that it has been proved by the use of mineral oils in lighthouses on the coasts of France, and by experiments in this country, that a great saving of expense and much greater illuminating effects are obtained by the use of mineral oils." It may be mentioned that Mr. M'Lagan is one of the largest proprietors of the Uphall Mineral Oil Works, which are only second in extent to the famous works at Bathgate and West Calder, established by Mr. James Young.

Clyde Trust—Engineer's Report.—At the ordinary monthly meeting of the Clyde Trust, held yesterday, an interesting report by Mr. Deas, the resident engineer, was submitted for consideration. It detailed extensive operations which have been made in the harbour of Glasgow and further down the Clyde in order to improve the navigation It stated that three of the four hopper barges which Mr. David Rowan is under contract to supply have been delivered, all of which are now at work, and the fourth having been launched on the 18th ult. The following is the programme of work for the new quarter now begun: Remove by dredging the river bank in front of the finished portion of Plantation Quay. Widen the river at Kelvinhaugh, and continue dredging from the river Kelvin to Elderslie. Continue deepening and widening from Dalmuir Works to Bowling, and the heightening of the river dykes, and the formation of the river embankments between same points. Commence the formation of the new road or street along the north side of the proposed Stobcross Docks. Commence the construction of the harbour tramways on the south side of the river.

Forth Telegraph Cable.—The oldest of the Forth telegraph cables has suddenly broken. It was laid in 1852—nearly twenty years ago—and has been frequently repaired since that date, but its existence has been looked upon as somewhat precarious for some years. Fortunately, however, the accident does not lead to the stoppage of any of the commercial wires communicating with Fife and the north; for the route of these wires has very recently been diverted round by Queensferry. The stoppage is only that of one or two railway wires, and even this is not serious, as there is an alternative route, which, by retransmission at Burntisland, provides for all the necessities of the case. No time will be lost, however, in making good the communication. A new cable is being got ready with all despatch by the Submarine Department of the Postal Telegraph System, and was to be shipped from London on Monday last. It will be submerged immediately the vessel reaches the Forth, so that within a week from the present time the full means of communication across the firth will probably be restored. The old cable will not be picked up at present, and it has been deemed prudent not to delay the expedition so long as would have been necessary to fit out a cable ship equal to the requirements of such an operation. But it will be none the worse for a few weeks', or months', longer submersion; and it will always be worth recovering, as the core is one of the best that was ever manufactured.

Extensive Alterations of Port-Glasgow Graving Dock.—The alteration and repairs of this, the oldest dry dock in Scotland, having been under consideration of the Harbour Trustees for a considerable period, they have, after receiving plans and specifications of the work, accepted the contract of Messrs. John Coghill and Co., of Glasgow, which amounts to 7000*l.* The work is to be completed in twelve months. Workmen have already commenced to float off the old gates.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a large attendance on 'Change at Middlesbrough. Business was brisk, and as much as 59s. per ton was paid for No. 3. This price, however, although quoted by several makers, is not realised generally. Lately the shipments in the Tees have been so numerous that there has been considerable difficulty in obtaining iron to complete cargoes, and hence the advance of 6d. or 1s. per ton, which was readily paid. There is a capital demand for iron, and the list rates are now as follows: No. 1, 58s.; No. 2, 52s.; and No. 3, 49s. 6d. Every furnace is kept fully at work. The number of contracts on hand is large. It is expected that the returns showing the make of pig iron in the North of England during July will show that the production is greater, and the stocks smaller. Yesterday on 'Change the fact that the Scotch ironmasters had shipped 101,000 tons of iron this year over that of last year was the subject of congratulation, especially as this increase has taken place in the face of the late war.

The New Works.—It is believed that the Lackenby blast furnaces will be blown in during the present month. Great progress is being made with Messrs. Gjers two new blast furnaces, Middlesbrough, and with a third of the new stack at Messrs. Samuelson, Newport, Middlesbrough. Messrs. Whitewell, at South Stockton, are making headway with the foundations for their new furnaces, and the Tees Bridge Iron Company, Stockton, will soon start to build their two furnaces. So rapidly is the Bowesfield Iron Company, Stockton, getting on with their finished iron works that they expect to be able to commence operations on the 1st of September. We hear that finished iron works are to be erected near the Middleton Iron Works, Fighting Cocks, Darlington.

The Nine Hours' Movement.—It is more difficult now to say when the strike in the engineering trade for the nine hours' movement at Newcastle-on-Tyne is likely to end. Within the last few days it has been stated that the masters intend opening their factories on the system adopted on the Clyde, viz., 56½ hours per week; conditions relating to overtime, &c., to be the same as on that river. The men have heard of this intention, and have again resolved to adhere to their determination to remain out on strike until the nine hours' movement is adopted. Should the men prove their words by their actions, it is believed that the masters will endeavour to procure workmen from abroad. In the meantime the number of men on strike is rapidly being reduced by large numbers emigrating to America, and obtaining situations in different parts of England. This week the league will be able to pay the men on strike 4s. 6d. each, and 1s. extra for each child. Subscriptions continue to come to hand from various parts of the kingdom.

The Docks at Middlesbrough.—The contractors are making rapid progress with the extension of the docks at Middlesbrough.

The Co-operative Engine Works at Newcastle-on-Tyne.—At a meeting held at Newcastle the other day in connexion with the Co-operative Engine Works, Ouseburn, the chairman stated that since they had started they not only had plenty of work, but, from the numerous inquiries they were receiving, the prospects were very encouraging.

The Wages of the Ironworkers.—The arbiter for the Board of Arbitration and Conciliation for the North of England Iron Trade, Mr. Thomas Hughes, M.P., has given his award respecting the claim of the ironworkers for an advance of 10 per cent. Mr. Hughes decides that there shall be an advance of 6d. per ton on the rate of wages paid to puddlers, and of 5 per cent. on the rate of wages paid to other workmen in the employment with the firms and persons represented at the Board, the advance to continue until the 31st of March, 1872, subject to such modifications (if any) that he may make after examining the books of the employers. Since Mr. Hughes made this award Mr. Thane, of Darlington, secretary to the ironworkers, has written him a lengthy letter, objecting to the award on several grounds, and asking him to reconsider it.

FOREIGN AND COLONIAL NOTES.

Steam Launch for South Australia.—Messrs. Yarrow and Hedley have supplied the engines for a twin screw launch built for the South Australian Government. The launch is 50 ft. 6 in. long, and her breadth of beam is 12 ft., while her depth is 5 ft. 3 in. She is built of American elm timber with Huon pine planking.

British Columbia and its Governor.—Mr. Trutch, the new governor of British Columbia, first arrived in that colony in 1859, and for several years he practised his profession there as a civil engineer. In 1864 he succeeded General Moody, R.E., as Chief Commissioner of Lands and Works. Mr. Trutch was born at Bath and is about forty years of age.

Science in the United States.—The American Association for the Advancement of Science will hold its twentieth annual meeting this year at Indianapolis. The proceedings will commence on Wednesday, August 16.

New Line of Transatlantic Steamers.—An effort is being made to establish a new weekly line of Transatlantic steamers between Montreal and Great Britain. The steamers employed will be of 3000 tons burthen; and they will run between Montreal and Liverpool in the summer, using Portland, Halifax, or some other Atlantic port in the winter months.

Public Works in South Australia.—Bonds for four new undertakings have been forwarded by the South Australian Government to its agent-general in London with a view to their negotiation. These bonds will, it is expected, raise 11,000*l.* for harbour improvements at Port Adelaide, 11,300*l.* for an extension of the Adelaide Water Works, 114,000*l.* for the Adelaide Suburban Water Works, and 26,000*l.* for the Port Adelaide Suburban Water Works.

Canadian Pacific Railway.—It is stated that a charter will be granted in the next session of the Parliament of the Dominion of Canada to a company which is to be formed for the construction of the Great Canadian Pacific Railway.

The Anglo-Brazilian Railways.—A Bill has been under the consideration of the Brazilian legislature for authorising the purchase by the Brazilian Government of the guaranteed Anglo-Brazilian Railways.

Indian Railways.—Preliminary surveys of a proposed railway from Nagpore *viâ* Kamptee through the Bandara district to Raepore have been laid out and sectioned. Designs and estimates for the Wurdah and Wurrora Coal Field Railway have received the preliminary sanction of the Government of India, and the formal sanction of the Secretary of State for India in Council is expected shortly. Mr. Molesworth, M.I.C.E., who is to act as consulting engineer for State Railways in India, has arrived at Calcutta. The Wurdah and Wurrora Coal Field Railway will be 50 miles in length, and will involve the construction of several important works, such as the Wunna, the Potra, and the Ambea river bridges.

Canadian Lighthouses.—The Trinity House Department at Montreal has invited tenders for the erection of a pier and lighthouse on Isle de Grace according to plans and specifications which have been prepared.

Balsa and San Francisco Railway.—Great economies have been introduced into the working of this railway. In 1869 the receipts failed to meet the working expenses by the sum of 4852*l.*, but in 1870 there was a surplus on revenue account of 691*l.*

Steam Haulage on Canal Banks.—M. Julien, of Bruges, has been officially authorised to establish a system of steam haulage on the canal from Bruges to Ostend. The haulage will be effected by means of road locomotives which are to run on the banks of the canal—a clumsy system.

Belgian Rails.—Official returns show that the exports of rails from Belgium have greatly declined this year. In April these exports amounted to 7480 tons, against 12,229 tons in April, 1870. The falling off in the exports to April 30 this year, as compared with the corresponding period of 1870 amounted to about 19,000 tons.

Montreal and Atlantic Junction Railway.—Some engineers engaged in surveying for a route for a contemplated Montreal and Atlantic Junction Railway, have reached Alexandria. They report that a good route has been found from the River Range Station, as well as from the Coteau Landing Station, on the Grand Trunk Railway.

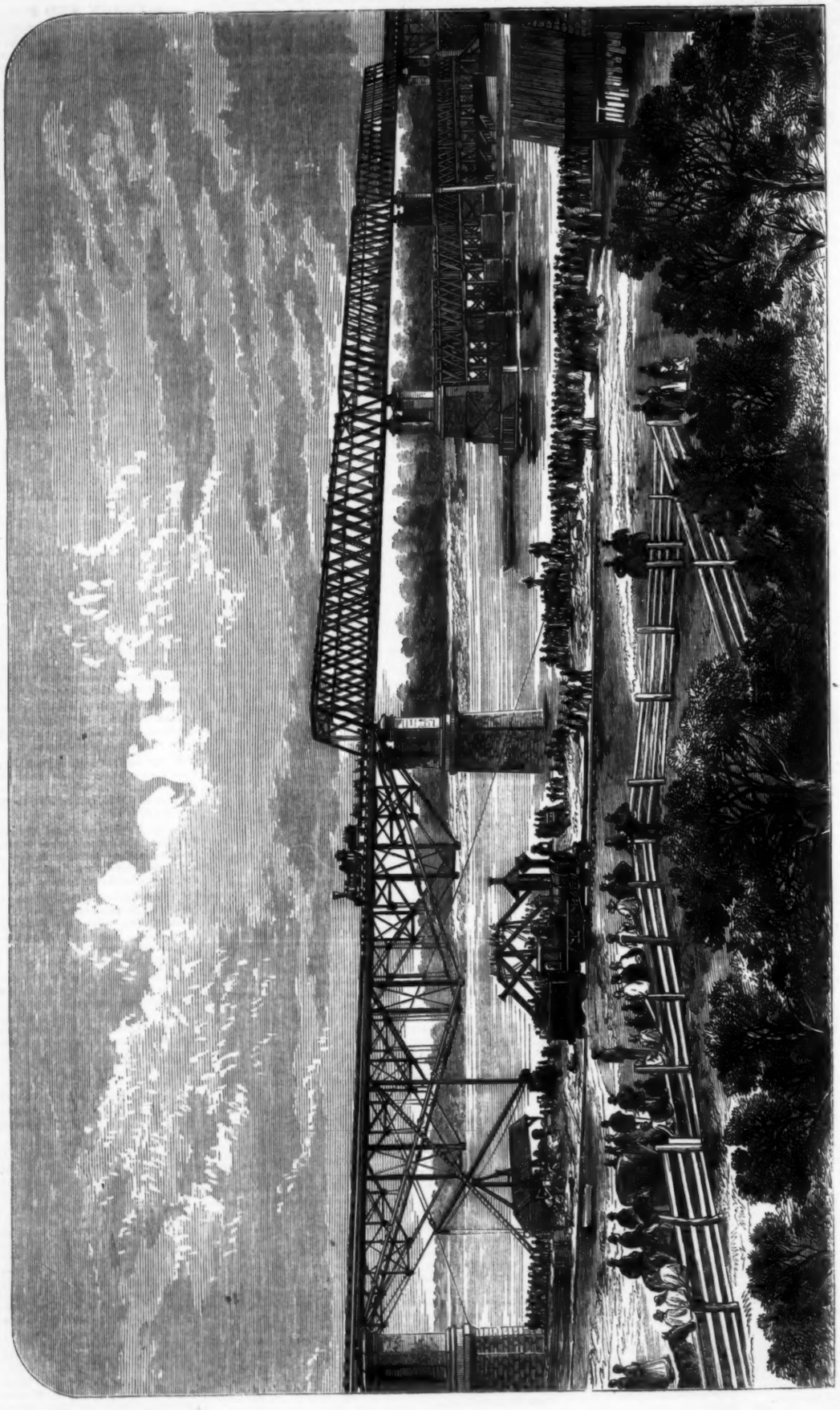
Steam Navigation on the Amazon.—It is proposed to transfer the undertaking of the Amazonas Navigation and Commerce Company to a foreign proprietary. The company earned last year a dividend of 12 per cent., and the commerce of the Amazon is rapidly increasing.

THE RUSSIA COPPER COMPANY.—A prospectus has just been issued of a company having for its object the purchase of certain large mineral and agricultural companies, situated in the districts of Orenburg and Ufa, in Eastern Russia, and including smelting works and rolling mills. These properties comprise about 200 square miles, rich in copper ore, which exist in beds varying from 2 to 9 ft. in thickness, and at depths of from 10 to 200 ft. In addition to this, large quantities of magnetic and hematite iron ore exist, and have been worked prosperously for very many years. The Voskresensky Smelting Works are very extensive, and are used for the smelting and refining of copper. Situated on forest lands they obtain ample supplies of charcoal. Besides six smelting furnaces and refineries, they contain all the necessary shops and appliances for the production and manufacture of copper. From the forest and pasture lands a large revenue is anticipated, the estimated amount being some 12,000*l.* a year, while that from the smelting works in their present condition is 35,000*l.* The capital of the projected company is 300,000*l.* The sum to be paid to the vendor of the property is 270,000*l.*, partly in debentures, leaving a working capital of 50,000*l.*

RAILWAY BRIDGE OVER THE RIVER MISSOURI AT ST. CHARLES, U.S.A.

MR. C. SHALOR SMITH, ENGINEER.

(For Description, see Page 72.)



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NOTICE TO AMERICAN SUBSCRIBERS.

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CONTENTS.

	PAGE		PAGE
Gramme's Magneto-Electric Machine	67	Agricultural Engine Trials	75
The British Association	67	Guns *v.* Targets	75
Tredgold's Elementary Principles of Carpentry	69	The Mont Cenis Tunnel	76
French Scientific Publications	69	Ice	76
Press for Forming Blocks of Dust Coal	71	The Institution of Mechanical Engineers	77
Kirk's Refrigerating Machine	71	Notes from Paris	80
The St. Charles Bridge	72	The President of the British Association	81
Notes from the South-West	72	Highland and Agricultural Society of Scotland	81
Notes from the North	73	Private Bills in Parliament	81
Foreign and Colonial Notes	73	Hydraulic Pressure Crushing Mill	82
Notes from Cleveland and the Northern Counties	73	Recent Patents	82

ENGINEERING.

FRIDAY, AUGUST 4, 1871.

AGRICULTURAL ENGINE TRIALS.

WE have on many occasions had occasion to speak of the great benefits which have resulted from the periodical trials of portable and fixed engines carried out under the auspices of the Royal Agricultural Society. It is true that for some years past many of the regulations under which those tests have been conducted have become antiquated and out of date, but in their earlier days the trials were undoubtedly of much use, and bore results which were beneficial alike to the makers and users of engines. These facts being borne in mind, the wish has, during the last few years, been frequently expressed, both in these columns and elsewhere, that the conditions of the competitive trials should be so modified as to make them accord more perfectly with the teachings of modern engineering experience. When the trials were first established portable engine building was in its infancy, and the fixed engines, then largely used for driving barn machinery, were of a very inferior class. At that time the Royal Agricultural Society had really to train up the engine-builders in the way they should go, and their rules had to be framed to suit the inferior class of machinery with which they had to deal. Now-a-days the state of affairs has become altered, and the leading firms of agricultural engine-builders, instead of having to be taught by the Society, are in a position to assume the office of teachers, and to instruct the Society in the manner in which the trials carried out by it may be advantageously modified.

Under these circumstances it was with much pleasure that we noted, in the rules issued to the competitive traction engine builders at the recent Wolverhampton Show, a strong disposition on the part of the Society to break down those barriers to further advancement which had marked the regulations under which the trials at Oxford the previous year had been carried out. At Wolverhampton each maker was left free to choose the pressure of steam used by him, the load under which his engine should be worked on the brake, and the speed at which it should be run. The beneficial effect of the liberty thus given was marked by the high results obtained by the best engines, and the hope has been excited that at the ensuing trials of portable engines at Cardiff next year, a similarly liberal policy will be followed, and far greater latitude allowed to the competitors as to the choice of conditions under which their engines are to work than has been the case on previous occasions. How far these expectations may be justified, we cannot at present say; but it appears to us worth while to direct attention to some points which appear to us to distinguish the conditions which it is desirable to enforce at the ensuing Cardiff trials from those adopted at Wolverhampton.

In the first place, when the Wolverhampton trials were announced, there were far from being sufficient reliable data available to enable it to be determined, with any degree of accuracy, what was the best size of traction engine for general agricultural purposes; and under these circumstances the loads against which the competitive engines were to be run on the brake were wisely left unfixed. In the case of ordinary portable engines, on the other hand, it is different, and there exist the results of ample experience to show what power is demanded from such engines as are ordinarily employed on a farm. There are, of course, exceptional instances in which engines are worked unusually hard; but, on the whole, it would be easy to estimate very closely the average performance of agricultural portable engines. Speaking broadly, such engines may, we consider, be divided into two classes, the first including the more powerful engines used not only for driving thrashing machinery, but also for working steam ploughing tackle on the roundabout system, while the second class would consist of those engines not sufficiently powerful for ploughing, but available for thrashing and other similar duties. Now, it appears to us that in such trials as those to be carried out at Cardiff, the various competitive engines might be advantageously divided into two such classes as those we have just mentioned, and a certain brake load having been fixed upon for each class, all engines should be tried at the load corresponding to the class to which they respectively belong. Let us suppose, for instance, that it has been found, from the recent experiments at Wolverhampton, that engines for working roundabout steam ploughing tackle should be capable of developing economically, say, thirty-two dynametrical horse power, and let us suppose that the results of experience have shown that for ordinary farm purposes a portable engine should be capable of developing sixteen dynametrical horse power without forcing, then 32 HP. and 16 HP., respectively, might be taken as the brake loads for the two classes we have suggested. We do not state that the loads we have just mentioned are the best which could be adopted; but we merely give them as examples of our meaning. What the precise loads should be, it would be easy for the engineers of the Royal Agricultural Society to decide from the ample data at their disposal, while, if thought desirable, a third or intermediate class might be introduced.

The loads for the two or three classes being fixed the greatest possible latitude should, we consider, be given to competitors as to the dimensions of the engines entered by them for trial in the different classes. It might perhaps, for certain reasons into which we need not enter here, be desirable to limit the pressure of steam to, say, 100 lb. per square inch in the case of engines competing in the first class, and to, say, 75 lb. per square inch in the case of those competing in the second or third class; but otherwise the makers should, we think, be left free and should be allowed to adopt any proportions of boilers, any size of cylinders, and any speeds which their experience might induce them to consider best.

It would, perhaps, not be one of the least advantages of the system of testing we have been advocating that it would get rid of that terrible bugbear, "nominal" horse power. The term "nominal horse power" is simply a disgrace to the present state of mechanical engineering. It has no scientific meaning, and it has long ceased to possess any but the most indefinite value as a commercial unit of measurement. As matters at present stand, and until steam users are more thoroughly convinced of its absurdity, it is impossible, perhaps, to discard the term altogether; but the Royal Agricultural Society will earn the thanks of the profession if they assist in abolishing the term by determining to give it no official recognition. So long as an engine does satisfactorily the work it is required to perform, it is of no importance whatever to the farmer at what power it may happen to be "rated" by its maker. The problem which the Royal Agricultural Society has before it may be very simply stated. It is: "The class of work to be performed being known, to select the best engine or engines for doing that work;" and this problem can, we consider, be best solved by abolishing from the regulations governing the trials all such purely arbitrary distinctions as "nominal" horse power, and running the engines under such loads as will fairly represent the work they will have to do in regular practice.

GUNS *VERSUS* TARGETS.

THE long-protracted battle between the guns and the targets appears to be as far off its close as ever. Although the war is not waged so fiercely now as it was a few years since, Shoeburyness still bears witness to the occasional advent of a new gun or a novel target. The most recent productions in these directions are the 11-inch Woolwich gun, and the 48-feet target, carrying in one port 13 in. of armour in two thicknesses, and 12 in. of teak, and in the other 8 in. of armour in one plate, with 18 in. of teak backing. Previously to this a target faced with 14 in. plates and backed with 9 in. of teak and a layer of 6 in. planks, with angle irons interposed, and another having 14 in. of iron divided into two plates of 8 in. and 6 in. respectively, separated by 9 in. and backed by 6 in. of teak were tried.* Here the targets were practically the victors, inasmuch as the compound 8 in. and 6 in., and the 14 in. solid plated targets both resisted the 11-inch gun. A reduction of 1 in. of iron and 6 in. of teak, however, turned the tables completely, and on the 12th of last month gave this gun the complete mastery. It sent projectiles, one after another, through the target with the greatest ease, and again confirmed these results on the 21st ult. The guns are, therefore, now in the ascendancy, the tide of victory having set in once more in their favour.

But the question which here presents itself is whether this victory is due solely to the superior penetrative power of the 11-inch gun, or whether it is not materially assisted by some structural deficiency in the target. And the conclusion that this may be so, is forced upon us by the remembrance of a series of experiments which took place at Shoeburyness on the 16th July, 1868, and at which we were present. The results were duly recorded by us at the time, and by referring to our report† it will be seen that there was a target which effectually kept out projectiles from the 9-inch 250-pounder, the 10-inch 400-pounder rifled gun, and the 15-inch 450-pounder American smooth-bore gun, each fired at 70 yards range. This target was the Millwall shield, which was faced in one part with 9 in. and in another with 6 in. plates, a third portion having 6 in. plates overlaid with three 1 in. plates. The whole of these plates were backed with Mr. Hughes's 7 in. hollow stringers placed horizontally, and rivetted to two ¾ in. skin-plates, and supported by plate and angle iron struts disposed in the usual manner. The shield was strengthened in the rear of the skin-plates by hollow stringers placed vertically. To support these stringers were box girders 12 in. deep, the whole being rivetted to a 1¼ in. rear plate and held together by 3¼ in. bolts. The spaces in the stringers and girders were filled in with wood.

Such was the structure against which the 9-inch gun was fired at 70 yards range, with a powder charge of 37 lb., equal to a full battering charge at 400 yards. The 10-inch gun at the same range was fired with 54 lb. of powder, equal to 60 lb. at 400 yards, whilst the Rodman 15-inch gun burned its full charge of 84½ lb. of powder. The 10-inch gun firing shells was also subsequently loaded with its full battering charge. Notwithstanding all this, and that the best and worst was done to admit daylight through the shield, the guns failed in penetration even when the shots entered previous holes, or struck upon the junction lines of the plates, and the Millwall shield remains unconquered to this day. Why, then, do we continue armour plating our ships and protecting our forts upon a system which has over and over again been proved incapable of stopping out shot, when we have a system of defensive armour which has never yet

* For the details of these and the previous targets and trials, see p. 339 of our last and p. 45 of our present volume.

† *Vide* ENGINEERING vol. vi. p. 57.

been vanquished? We prove in 1868 that we have a target which is practically invulnerable, and yet we go on till now building up others only to demolish them. Irrespective of the vast sums of money expended upon these experimental targets and their trials, the principle of having them at all is open to objection. We could understand it if there were no such thing as an unpenetrated Millwall shield, as the object presumably is to obtain the best system of defence we can, and of course this is not to be done without patient investigation and practical experiment. How then does it happen that the War Office should have turned aside from a most promising system, and have adopted another which has never given such good results?

We do not pretend to be in the secrets of the administration, nor are we aware of the causes which influence our authorities in their line of action, but economical motives are possibly paramount. As a matter of course, if Mr. Hughes's hollow stringers were adopted in our defensive structures, the Government would have to pay Mr. Hughes royalties upon his patent, and it may be with the object of saving this expense, that they have substituted shields of their own design, which our guns can knock to pieces; the satisfaction of saving a few thousand pounds in royalties is but a poor compensation for unsatisfactory defences—besides much money has probably been spent in developing the Government plans. It is indeed an utterly false economy, for the money that has been expended on piercing official targets, since 1868, would have gone far to compensate private inventors. Had the hollow stringer system been properly tested when its merits were first demonstrated, we should probably by this time have better reason to be satisfied with our ships and forts. The inattention and indifference which have characterised the action of the Government in this matter have not been imitated by other Powers, who, alive to the necessity of securing the best means of defence and of offence, free, moreover, from the endless routine and pernicious prejudices which appear to envelope our War Office, have investigated, experimented upon, and freely adopted systems neglected and rejected here. The time may be far distant—we hope it may never come—when the gigantic preparations for war now being made abroad will be turned into use against us, but should it ever arrive we shall know that the ironclads which will compete with our fighting fleet, have, in part, at all events, been designed by the man driven from service here, and invited to give assistance to foreign powers, and that the armour that protects them was submitted first to us, and, being refused, was offered and accepted elsewhere.

However, there is yet time to set ourselves right in this matter, and if it be true—as we believe it is—that Mr. Hughes intends to send another and still better shield to Shoeburyness for trial, we trust that it will have the careful consideration of the War Office and Admiralty authorities. Let the system have a fair and equal chance with competitive designs, and if it still continues to give favourable results, there can then be no reason, and still less any excuse, for its non-adoption. Costly as the Shoeburyness experiments have been, and yet will be, we live in the hope of seeing them bear fruit one day. That will be when a careful investigation of the whole results shall have been made by competent and unbiassed judges.

THE MONT CENIS TUNNEL.

NUMEROUS disparaging rumours have of late been afloat respecting the Mont Cenis Tunnel. It was said that the arch had fallen in for a length of 170 ft., it was affirmed that the heat in the tunnel was insupportable, and that engine drivers had been suffocated from the smoke of the locomotives. There has never been one stone displaced from the finished arch of the Alpine tunnel, the work of which is so solidly constructed that it is well nigh as durable as the rocks themselves. The only circumstance which served as a foundation for these absurd reports was the falling in of 18 or 20 ft. of work, which happened in the last days of June at the Bardonnèche end, in consequence of the falling of some scaffolding broken by the explosion of a blasting charge. In this accident two workmen were killed and five were injured.

As yet no experiments have been made with steam working through the tunnel, but all evidence goes to show that locomotives will fulfil all the requirements, and will do the duty well. Good ventilation is well established, and if it should be found insufficient, the compressors so long employed in the work of excavation, and which have been now idle for so long a time, can be used at both ends. The heat is not excessive; before the completion of the work it did not exceed 82 or 84 degrees, and since the piercing was completed the temperature is so moderate, that the workmen have no longer any necessity for working stripped to the waist, the through draught of air creating a decided ventilation in the tunnel.

ICE.

ALTHOUGH the use of ice for cooling water and other liquids in summer has long been regarded as one of the necessaries of life in most countries, yet in England it is only within the last fifteen years or so that it has been considered in this light. It was formerly looked upon as a luxury in which few but the wealthy ever thought of indulging. The use of ice, however, in the United Kingdom has rapidly increased during the above-mentioned period, and it is fast becoming a necessity in every household. The practice of cooling summer drinks and food is very ancient, and the use of ice for this and similar purposes is advisable upon economic grounds, and is demanded both by health and taste. There are two sources from which the supplies of ice are obtainable, the natural and the artificial, and we propose offering a few remarks upon both of these methods of supply. First, then, the natural. The most simple and obvious method of securing a magazine of cold to meet the physical wants of summer is to collect, during the winter, a store of ice, and to place it under such conditions as shall insure its being preserved intact for use as required. In Great Britain the collection and storing of ice is very precarious, on account of the uncertainty of the supply during our mild winters. In America, however, where the cold of winter is intense, the cutting, storing, and transportation of the ice is regularly carried on throughout the winter. But, although the home supply is uncertain, every advantage is taken of the least frost by the London costermongers to earn a few shillings by bringing rough ice from the suburban canals and ponds to the ice wells around the metropolis.

The ice trade of London and the suburbs is in the hands of some half-dozen merchants, and their wells, or "shades," as they are sometimes called, are not very numerous. There is one of these wells in the Caledonian-road, near the New Cattle Market, and its exterior simply presents the appearance of a brick-built, windowless round house. This well is 72 ft. deep, and 42 ft. in circumference, and, when filled, contains 3000 tons of rough ice. As it is shot in by the ice-getters it is broken up, and well packed together, and levelled with shovels, forming in time a compact mass, so solid that it has to be hewn with axes when required for the market. The shrinking of this dense block from the wall on all sides is only 6 in. This remarkable tendency to cohesion in particles of melting ice is known as regelation, and was first noticed by Faraday, who showed that if a slab of ice were simply superposed upon another the two would cohere, even if immersed in warm water. The cause of this phenomenon has been the subject of much controversy, but the simplest explanation is that given by Faraday himself. His reasoning is, in brief, that a liquid film immediately forms over the fractured surfaces of a block of ice. This film being excessively thin, on the pieces of ice being brought together again, the force of cohesion is able to act across it, and the liquids pass back into the solid state, and the block is reunited by regelation. Professor Tyndall has shown that a flat cake of ice may be converted into a hemispherical cup by simple pressure in a mould, a very short time being required for the regelation of the displaced and compressed fragments. The rough ice is consumed in large quantities by fishmongers, and fishing smacks are enabled to remain at sea a week or ten days by the aid of the ice they carry with them, and in which the fish is packed away as fast as it is caught.

Such is the rough, or local ice supply; but there is yet another kind of ice, the foreign, which is chiefly used for the refrigerator and for table purposes. We are all familiar with the glittering cubes of pure crystal to be seen in the windows of the Wenham Lake Ice Company's depôt in the Strand. These blocks, it is now well known, are all procured from Norway by that company, which formerly obtained its supply from Wenham Lake, near Boston, United States. The expense of freight, however, rendered it so costly that they were obliged to seek a source of supply nearer home, and they found it in Norway. The new Wenham Lake occupies an elevated position, and is situated among rugged hills a few miles from Drobäk, in Christiania Fjord. The water is very pure, the lake being fed entirely by springs which issue from the rocks at its bottom at a depth of 200 ft. From this source all the pure table ice is supplied. The process of reaping the ice crop in Norway is the same as in America. When the ice is about a foot thick a surface of about 2 acres is selected, which, at that thickness, will furnish about 2000 tons of crystal ice. By the aid of a sharp ice-plough the surface is ruled with parallel lines 21 in. apart, and when the whole surface is marked in one direction the plough is set to work at right angles. In this manner the whole area is divided up into squares of 21 in., after which the ice saw divides these parallel lines, and by the aid of the ice spade—a sharp wedge-formed implement—the squares are split apart with the utmost rapidity. Forty men, assisted by 12 horses, will cut and stow away 400 tons per day; at times as many as 100 men are engaged on this work at the same time. The ice is stowed away in an adjacent ice-house, which is capable of holding 20,000 tons of ice. It is constructed of timber, with double walls 2 ft. apart, the intervening space being filled in with sawdust. The ice stores are on a very large scale, sufficient to afford a supply for two and sometimes three years. It may appear somewhat singular to talk of ice two years old, but as a fact much of the table ice that is used is often the product of the Wenham Lake harvest of two years previously, but this is no uncommon length of time for preserving it. The blocks of ice are shipped to England, and packed in the stores with layers of sawdust between them to prevent regelation. The loss from the time of loading into the ship to the time of purchase by customers in England is stated to be about 50 per cent., not a very large amount, considering the exposure to which the blocks are sometimes subjected in very hot weather.

The ice trade is of considerable importance and magnitude. In North America and Northern Europe vast quantities are collected both for home consumption and for exportation. In America alone it is estimated that 10,000 persons were formerly employed in the ice trade, and the capital invested was about six millions of dollars. Boston, which represents one of the most active centres of the trade, frequently stores up 300,000 tons in a single winter. Previously to the war, however, a large proportion of this was taken by cities further south. In this way 110,000 tons were disposed of in 1854, whilst the East Indies received 14,284 tons. New York stores up an amount nearly as great as does Boston, but only a small proportion—some 20,000 tons—is exported. Although the ice trade between America and Europe has fallen off of late years through the greater accessibility of the supply from Norway to which we have referred, the former country still monopolises the supply to the West Indies, the South American continent, the East Indies, India, and China. The crop of the winter of 1867-68, which seemed to be providentially abundant in contemplation of the ensuing hot season, was one of the finest ever known. No less than 88,496 tons were cleared for export from Boston in that year to the countries we have mentioned. The waste on the voyage in these warm latitudes renders block ice so costly in Australia that it is found more economical to produce it artificially.

In Europe large quantities are collected, and to such an extent that even the glaciers are made to furnish their quota. Thus at the Grindelwald we hear of hundreds of men being employed in cutting the ice into blocks for sale. In the summer of 1869 Paris commenced taking large supplies of glacier ice from Switzerland—an innovation which promised to revolutionise the ice trade, and to convert the desert mountain peaks of the Alps into rich harvest fields. The imports of ice from abroad into England vary much, being dependent upon the quantity of rough ice in stock from the previous winter's harvest. For this reason all figures relating to the imports of the commodity are only approximate as tests of the aggregate quantity consumed, although they help to indicate the steady increase. Thus the last winter having been productive of good home ice harvests, the imports may probably be reduced during the present season. They will also be

affected by this exceptionally cold summer. As showing, however, the constant increase in the consumption of ice in this country we may mention that in 1854 the imports were only 2000 tons; in 1865, out of 44,823 tons of ice exported from Norway, this island received 43,359 tons, whilst in 1869 there were no less than 110,000 tons imported into England.

The quality of ice is an all-important question, as for table purposes it must be absolutely pure. It is generally supposed that water, while in the act of congelation, is purged from all foreign matter, but this is only partially true. All the mineral salt the water may contain, as well as any colouring matter, are removed from it, but no organic matter is eliminated in the process. For this reason the clearness of the ice is no test of its purity, and some of the most glittering ice has been found to fairly stink when dissolved. It is as well to mention this fact, that it may be known that the eye is not the most perfect test of the purity of ice, the sense of smell must be called in to its aid. The Wenham Lake Ice Company took the precaution of satisfying themselves that the piece of water from which they proposed to draw their supplies was free from any impurity before they purchased it. Having assured themselves on this point, they not only purchased the lake, but the farms surrounding it, in order to keep it in their own hands, and to secure perfect immunity from any deleterious local drainage. We have thus far noticed the nature and extent of our natural ice supply, as well as the sources from which that supply is obtained. It remains now to describe the second general source of supply—the artificial—and this branch of the subject we leave for another notice.

THE INSTITUTION OF MECHANICAL ENGINEERS.

IN our last week's report of the meeting of this Institution, at Middlesbrough, we referred briefly to the paper read, last Wednesday week, by Mr. Charles Cochrane, "On Steam Boilers with Small Water Spaces and Root's Tube Boiler." In these days of high-pressures, the subject dealt with by Mr. Cochrane has acquired an importance which is ever increasing, and, as was to have been expected, therefore, the paper just mentioned was one which attracted much attention.

Commencing with some remarks on boilers in general, the author gave a Table, which we reproduce below, showing the proportions between the heating surface, water contents, and space occupied by boilers of various types, an ordinary Cornish boiler with 500 square feet of heating surface being taken as the unit of comparison. Next Mr. Cochrane gave a brief historical notice of the various classes of boilers with small water spaces, and spoke of the boilers of Woolf, Hancock, Ogle, James, Perkins, Belleville, Jordan, Harrison, Benson, Field, Howard, Allen, and Root. Woolf's boiler, which was the first of its class, consisted of a number of cylindrical barrels of comparatively small diameter placed side by side, these barrels communicating with another at a higher level which served as a steam chamber. Hancock's boilers and several others which succeeded them were brought into existence by the demand for a light boiler suitable for employment on steam carriages for common roads. One form of Hancock's boiler consisted of a number of flat water chambers placed vertically, at a short distance apart and connected at the top and bottom, these chambers being exposed to the fire; but the fact of the use of such spaces involving much staying led to their being abandoned. Ogle's boiler consisted of a number of vertical tubes connected by horizontal branches, and exposed to the fire, each tube being traversed by an internal tube, which afforded additional heating surface; and James's boiler was made up of a number of annular tubes of square section, these rings being placed side by side, so as to form a kind of flue, in which the firegrate was situated. Perkins's boiler, built up of a number of horizontal tubes of small diameter connected at their alternate ends by short vertical junction pieces screwed into them, is well known to most of our readers, while the Belleville and Jordan boilers have been fully described in our pages.* The Harrison boiler—consisting of a number of cast-iron spheres strung on wrought-iron tie-rods which served to secure them together—proved a complete failure in this country, although we believe that it is still in use in the United States, while the Benson boiler, another American invention, has only been used here to a very limited extent. The Benson boiler closely resembles in its general construction that of M. Belleville; but it differs from the latter in being provided with a pump for producing a forced circulation. The Field and Howard boilers are both thoroughly well-known, while the Allen boiler consists of a number of horizontal tubes from which hang a series of pendant tubes inclined in the direction of the current of hot gases. The pendant tubes are completely, and the horizontal tubes partially filled with water, and the difference between the temperature of that side of each pendant tube exposed to the direct impact of the hot gases and the opposite side, together with the inclined position of the tubes, is depended upon to produce the necessary circulation. We have ourselves received from the other side of the Atlantic very favourable reports as to the performance of the Allen boiler; but none of these reports furnish sufficiently precise data to enable us to form any definite opinion as to the real efficiency of the arrangement. The last boiler dealt with by Mr. Cochrane was Root's, special reference being made to two boilers of this class at present in use at the Ormesby Iron Works, and of the performance of which the author spoke highly. The Root boiler has already been illustrated and described in our pages (*vide* page 102 of our ninth volume), and we need not therefore re-describe its details here. We should state, however, that since we illustrated it, several improvements have been made in the mode of connecting the tubes of which it is composed. Each of the boilers at the Ormesby Works consists of 90 tubes 9 ft. long, placed at an inclination of 1 in 3, the tubes in the lower rows being 4 in., and those in the upper rows 5 in. in diameter, while the total heating surface exposed is 920 square feet. One of these boilers is being worked with coal, and the other with gases from the blast furnaces, and a careful record is being kept of the evaporative results. According to one experiment, recorded by Mr. Cochrane, 10¼ lb. of water were evaporated per pound of coal, the evaporation being effected under a pressure of 50lb., and at the rate of 183 gallons per hour, while on another occasion, mentioned in the course of the discussion, 650 gallons of feed water were used in 3 hours 35 min., the consumption of coal in the same time being 5 cwt. 2 qr. 17 lb. We have said that 650 gallons of water were "used," and we have employed this term because the whole was not evaporated, 20 gallons being blown off. The temperature of the feed was not stated; but we may probably take the water blown off as being approximately equal to four gallons evaporated, and making this assumption, it will be seen that the evaporation was almost precisely 10 lb. of water per pound of coal. This is a high result, but it must be borne in mind that the total quantity of water evaporated was small in proportion to the size of the boiler, being at the rate of but 117 gallons per hour, or but 1.92 lb. per square foot of heating surface per hour. Mr. Cochrane explained this by stating that at present arrangements had not been made for furnishing to the boilers the supply of feed they would require when in full work, and hence the above results. We trust, however, that on a future occasion Mr. Cochrane may furnish to the Institution a report of the performance of the boilers when doing their full duty, as this would possess much interest for the purposes of comparison. The Root's boilers at the Ormesby Iron Works are, we should state, being worked with water which has passed through the tuyeres of the blast furnaces, &c., and this water is of such exceedingly bad quality that even at the present time, when the boilers are being very easily worked, they have to be blown off every four hours and cleaned out every six weeks, this latter operation, however, taking but eighteen hours per boiler, as the interior of the tubes are readily exposed by the removal of the end caps and the connecting pieces. It is, we think, somewhat curious, considering the bad quality of the water available at a number of the works in the Cleveland district, that surface condensers are not more generally employed. Such condensers, if used merely for condensing steam into water under atmospheric pressure, and not for producing a vacuum, would require far less surface than is necessary under the latter conditions, and they could, moreover, be very easily kept in repair. Mr. Cochrane's paper was followed by a somewhat lengthy discussion, but of this our space will not permit us to speak here.

TABLE SHOWING THE PROPORTIONS BETWEEN THE HEATING SURFACE, WATER CONTENTS, AND SPACE OCCUPIED BY BOILERS OF VARIOUS TYPES.

Class of Boiler.	Heating surface.	Water contents.	Space occupied.	Approximate dimensions.
	sq. ft.	cub. ft.	cub. ft.	
Chimney ...	500	1120	3000	4 boilers, each 25 ft. high by 5 ft. diameter, with 2½ ft. flue
Balloon ...	500	1005	10,000	1 boiler, 18 ft. high by 18 ft. diameter
Furnace ...	500	909	7680	1 boiler 25 ft. by 9½ ft.
Cylinder ...	500	775	4000	1 boiler 80 ft. long by 4½ ft. diameter
Lancashire ...	500	404	2700	1 boiler 28 ft. long by 6½ ft. diameter, with 2½ ft. flue
Cornish ...	500	375	2900	1 boiler 30 ft. long by 6½ ft. diameter, with 4 ft. flue
Locomotive ...	500	70	360	1 boiler 10 ft. long by 4 ft. diameter
Tube boilers (average)	500	40	760	1 boiler 60 or more tubes
Fire engines...	500	27	250	5 boilers, each 5 ft. by 2 ft.

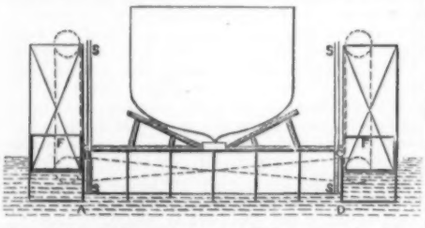
We have already mentioned that the afternoons of Tuesday and Wednesday week were devoted by the members to visiting the works in the neighbourhood of Middlesbrough, and in our last number we gave some particulars of a few of the establishments thus inspected, while of others accounts have appeared in former volumes of this journal. We must, however, say a few words here concerning the Newport Rolling Mills, belonging to Messrs. Fox, Head, and Co., where there were to be seen in operation a number of the patent puddling furnaces, illustrated and described by us on page 53 of our ninth volume. In these furnaces the air for supporting combustion is injected by the aid of a steam jet into cast-iron heating pipes exposed to the escaping gases, and in the furnaces of the most recent pattern its temperature is thus raised to about 650° before being brought into contact with the fuel. At the Newport Rolling Mills all the puddling furnaces, forty in number, are being gradually rebuilt upon the new system, those furnaces already altered giving exceedingly favourable results, the consumption of coal being, in the furnaces including the most recent improvements, but 13 cwt. per ton of puddled bar produced.

The plant at the Newport Rolling Mills includes a forge train with reversing gear, and a fine reversing plate mill, the clutches for reversing being in both these trains moved over by steam power. All the mill engines are fitted with Mr. Head's crossed-arm governors, of which we spoke last week, and these latter are so sensitive that it is impossible to notice an alteration in the speed of the engines during the passage of a bloom through the rolls, either by counting, or by the more sensitive test of listening to the gearing. Another of these governors is fitted to a shearing machine driven by an independent engine, and in this case the promptness of action of the apparatus is especially noticeable, no variation of speed being observable when the cuts are made. One of the mill engines, also, is fitted with Ashton and Storey's continuous indicator, or steam power meter, an instrument which has already been described in our pages, and of which we have several times had occasion to speak favourably. By the aid of this apparatus a continuous record is obtained of the power exerted by the engine, the work done being, as it were, continually added up, so that the total amount can be at any time read off from the dial. The instrument, in fact, serves a most important purpose, and as it has now been fairly tested for long periods of time with most satisfactory results, we hope to see it come into extensive use. When the power exerted by an engine is very variable, as is the case in a rolling mill, this power meter forms almost the only means with which we are acquainted for obtaining a record of the work actually done. Before taking leave of the Newport Rolling Mills, we should mention the method adopted there of mounting the steam-hammer cylinders. Instead of fixing these cylinders direct to the standards as usual, each is attached to a series of superposed wrought-iron plates, these plates being fixed to the tops of the standards, with distance pieces interposed between their ends and the latter. The effect of this arrangement is that the plates, which spring at each stroke, form a kind of elastic bridge upon which the cylinder is mounted, and the latter is thus shielded from the shocks to which it would otherwise be exposed. The arrangement is stated to have completely prevented any breakage of hammer cylinders since its adoption.

During the meeting a number of objects of in-

* *Vide* pages 138 and 140 of our ninth volume, and page 318 of our first volume respectively.

terest were exhibited at the Exchange Rooms, Middlesbrough, and some of these exhibits we must notice here. Thus Mr. William Bouch, the locomotive superintendent of the Stockton and Darlington line, exhibited a model of his ingenious combined screw and lever reversing gear—which has already been described in our columns, and which is decidedly the neatest arrangement of its class yet proposed—and also a set of link motion taken from one of his goods engines after having run over 200,000 miles without repairs. This valve motion was well worthy of the careful attention of locomotive engineers, as, with the exception of a slight looseness in the lifting links, it absolutely showed no signs of wear. This result had been obtained simply by providing ample bearing surfaces. The expansion link was of the double-bar kind, each bar being 1 in. thick, and the sliding block being 9 in. long, so that there is no less than 18 square inches of bearing surface to resist the strain in either direction. The studs for the eccentric rods also are 3 in. in diameter, and the journal which forms the connexion between the two sides of the sliding block, and which is embraced by the end of the valve spindle, is of the same dimensions. Notwithstanding the large bearing surfaces provided, there is no approach to clumsiness in the proportions of this valve motion, and it is, in fact, one well worthy of imitation. Another exhibit of interest was a model of Janicki's floating dock shown by Mr. Henry Simon, of Manchester. We intend next week to describe this dock fully, and meantime we give the subjoined sketch, which will show its leading features. The main carrying por-



tion of the dock consists, as will be seen, of a large bottomless pontoon, A B C D, this pontoon being divided into compartments into which air is pumped, for the purpose of giving the necessary floating power. As the dock rises, the air in these compartments will of course expand and this expansion might, by increasing the displacement, cause some trouble if means were not taken to prevent it by providing safety tubes, S S, open at both ends, through which the air as it expands can escape. Floats, F F, are provided on both sides, these being so connected to each other by chains that they are always in a plane parallel to the dock itself, and rise and fall automatically with the dock. This method of constructing floating docks appears to us to possess several important advantages, and of these we shall speak in due course when we describe M. Janicki's plans fully. Messrs. Gilkes, Wilson, Pease, and Co. exhibited drawings of a blowing engine regulator and boilers as made by them, and which we intend shortly to illustrate, while Messrs. Fox, Head, and Co., showed an excellent model of their puddling furnace, and Mr. Whitwell models of his blast heating stoves already described in our pages. A considerable number of these stoves are now in use, and we hear very satisfactory reports of their performance.

The morning of yesterday week was spent by the members in visiting various works at Stockton, including amongst others Messrs. Blair and Co.'s marine engine and boiler works—where there was a pair of compound engines in process of erection, and others in progress, and where one of Mr. R. H. Tweddell's hydraulic rivetters was shown in operation — Messrs. M. Pearse and Co.'s, and Messrs. Richardson and Duck s shipbuilding yards, Messrs. R. Morton and Co.'s brass works, Messrs. Head, Wrightson, and Co., foundries and bridge works, &c., the Thornaby Iron Works, of Messrs. Whitwell and Co., and numerous other establishments. The limited space at our disposal renders it quite impossible that we should enter into accounts of these various works here, but we shall take future opportunities of referring to the specialities which we noticed at several of them. In the afternoon, after leaving Stockton, and making a brief stay at Middlesbrough for lunch, the members were conveyed by special train to Eston Junction, where they visited Messrs. Bolckow, Vaughan, and Co.'s Cleveland blast furnaces, and Mr. Thomas Vaughan's furnaces at Clay Lane and South Bank. At Eston there are five, at Clay Lane six, and at South Bank nine, furnaces now in blast, while at the first-mentioned establishment Messrs. Bolckow, Vaughan, and Co., are putting up two new furnaces. At Eston the members had an opportunity of inspecting Mr. Borrie's conveniently arranged calcining kilns, illustrated by us on pages 348 and 352 of our eighth volume. In these kilns the calcined ore is delivered at the bottom by shoots direct into the wagons or barrows by which it is conveyed to the blast furnaces, there being thus a material saving of manual labour. The "flow," if we may term it so, of the materials down the shoots, is checked by sliding plates, these plates being situated at some distance from the openings through which the materials issue from the kilns. The object of this is to allow the materials to form their natural slope after issuing from the kilns, and then, by placing the slides at the foot of these slopes, cause them to be subjected to very slight pressure. This ingenious expedient is perfectly successful, and the slides belonging to the kilns at Eston can be moved with great ease, whereas if they were placed close to the openings in the kilns, and made the same size as at present, they would each be subjected to a pressure of about 2¾ tons.

From Eston the members proceeded by train to Lackenby where they inspected the new iron works which have just been completed, and the plant of which includes the compound blowing engines, illustrated by us the week before last. These engines are being erected by Messrs. Kitson, and are in an advanced state, as are also the boilers which have been made by Messrs. Howard, of Bedford. We notice, by-the-bye, that in this case Messrs. Howard are putting up boilers of their marine type, namely, those in which the tubes are nearly horizontal, and are only connected to vertical pipes at one end. We, however, ourselves much prefer their boilers with the vertical tubes, and we are convinced that ultimately the latter will be found to be the preferable arrangement. From Lackenby the party were conveyed to the South Gare at the mouth of the Tees, where a slag breakwater is in progress of construction. This breakwater commences at Tod's Point, near Coatham, and will, when completed, be about 12,800 ft. in length. Its construction was commenced by the Tees Conservancy Commissioners, in 1861, and the deposition of the slag blocks was begun in 1863, while up to the end of last year 2,002,708 tons of slag had been deposited at a cost of 68,901*l.* 17*s.* 5*d.* During the present year but about 100,000 tons of slag have been deposited, but during the few years previous it was tipped at the rate of about 1000 tons per working day. At one time special tipping arrangements were in use to enable the operation to be carried on almost continuously, but at present the tipping is performed in the ordinary way. During the progress of the work large quantities of slag have from time to time been washed away from the outermost point of the breakwater, and deposited by the action of the waves in curiously-formed banks on either side. To check this the plan is now being resorted to of sinking a strong timber crib filled with slag some fifty yards or so in advance of the work, and then tipping the material until the main body of the breakwater is made up to this crib, which is ultimately entirely buried. On the crib being reached a similar new crib will be sunk 50 yards in advance, and so on, the cribs thus sunk serving to protect the point of the breakwater from the direct impact of the waves. Since the breakwater has been in progress large areas of very valuable land have been reclaimed along the south side of the Tees and other reclamation works are now going on. The present breakwater will not be extended much beyond its present length, but arrangements are in progress for commencing the construction of a second breakwater, extending from the northern side of the mouth of the river. This new breakwater will also be made of slag, but, instead of this material being conveyed by rail, it will—at first, at all events—be deposited from keels or hopper barges. After inspecting the breakwater works, the members proceeded to Saltburn, where, in the evening, a dinner was given by the Cleveland iron and engineering trades.

Last Friday was devoted to visiting some of the ironstone mines, the members being first conveyed, by special train from Middlesbrough, to the Spa mine, belonging to Messrs. Bell Brothers. At this mine a seam, about 9 ft. thick, is being worked, and about 500 tons of ironstone are being got out per day. The workings follow the dip of the seam, which is at the rate of between 2 in. and 3 in. per yard, and the wagons are hauled out by being attached to a wire rope led over guide pulleys to a winding engine near the entrance. The ventilation is effected by a furnace at the foot of a shaft 180 ft. deep, but, owing to this very moderate depth of shaft, and the consequently small height of the motive column of air, the system of furnace ventilation is in this case expensive, and it is not improbable that mechanical ventilation may ultimately be resorted to. We may notice here that the holes bored in the Cleveland mines for blasting purposes, instead of being circular, as is usual, are of triangular section, the boring bar or jumper, instead of being turned partly round on its axis, being partly turned on each side of its cutting edge alternately. There is no difficulty in boring the holes to this shape, and they are found to be somewhat more effective than the round holes, the corners forming points at which the fracture of the stone appears to commence, the line of fracture in most cases seeming to form a prolongation of one side of the triangle. The holes are from 3 ft. to about 4 ft. 6 in. deep, the average length being about 3 ft. 6 in., and an ordinary hole is made in from 30 to 40 minutes. The charges of powder used vary from 1 lb. to 2 lb., according to circumstances.

From the Spa mine the party proceeded to the Cliff mine, where there is a shaft descending to workings in a 7 ft. seam, and thence to the Huncliff mine, about a quarter of a mile distant, the railway between the two passing around a point of the cliff, 300 ft. above the sea. The Cliff and the Huncliff mines both belong to Messrs. Bell Brothers, and the workings communicate with each other. At the Huncliff mine the hauling out of the loaded wagons is done by an engine made by Messrs. John Fowler and Co., of Leeds. This engine is of the same general pattern as their ploughing engines; but the crankshaft and countershaft bearings are carried by a cast-iron framing mounted on the boiler, and connecting them with the cylinders, while the winding drums are mounted on a horizontal shaft carried by independent framing. The whole engine and boiler is mounted considerably above the adjacent ground level, on piers of cement concrete, which appear to serve their purpose admirably. The engine just referred to does its work very satisfactorily, and raises 1000 tons of ore 20 fathoms with a consumption of 7 cwt. of coals. We may mention here that altogether Messrs. Bell Brothers are now drawing 15,000 tons of ore per week from their various mines.

Leaving Huncliff, a visit was next paid to the Liverton mines, where there was a new winding engine to be inspected. At the time of the visit the winding at the main shafts was being done by a pair of engines made by Mr. Robert Daglish, of St. Helens, these engines being geared to the drum shaft; but the new and larger engines which have just been erected by the Sandycroft Foundry Company, of Chester, are now ready for work, and they were, in fact, shown running on Friday last. They have a pair of 30 in. cylinders, with 5 ft. stroke, and the cranks are fixed on the end of the drum shaft, so that the drum, which is 10 ft. in diameter, is driven direct. As far as workmanship goes, the engines appear to be a very good job; but their design is much marred by the manner in which the eccentric rods have been arranged. The valves are of the equilibrium class, lifted by arms on rocking shafts, which are in their turn actuated by link motion. The eccentric rods are very long, and to save lifting their whole length with the link, each rod is jointed at the centre of its length, and attached there to the upper end of a vertical rocking arm. The effect of this, of course, is that when the engines are reversed that part of each eccentric rod which is between the joint just mentioned and the expansion link, is alone lifted up or depressed. So far the arrangement is a good one, but unfortunately the eccentric rods have not been planned to extend in a straight line from the eccentric straps to the expansion link, but that portion of each rod lying between the eccentric strap and the middle joint is made to slope away horizontally at a considerable angle with the centre line of the engine, and thus an objectionable side strain is placed upon the rocking arms by which the joints at the middle of the length of the rods are supported. This strain the arms are unfitted to resist, and as the alternating strains on the two eccentric

rods of each engine tend to alternately force the arms together, and draw them apart, and as the clearance is but small, we fear that before the bearings have become much worn striking will take place between the rocking arms.

From Liverton the party proceeded to the Skinningrove mine of Messrs. J. and J. W. Pease, passing on their way over the Kilton viaduct. The latter, which is on a curve, is situated at a great height above the valley, and consists of lattice girders supported by stone piers. The descent into the valley in which the Skinningrove mine is situated, is effected by a zigzag, averaging, we believe, 1 in 40, but having some portions as steep as 1 in 33. The valley of which we are now speaking possesses an historical interest from the fact of the Cleveland ironstone having been first discovered at its mouth, and the spot from which the first samples were taken was pointed our to the visitors last Friday. Of the Skinningrove mine there is but little to say except that it is worked by extensive levels, and that the haulage is performed by an endless rope driven by one of Messrs. John Fowler and Co.'s clip drum ploughing engines situated at the principal entrance. A second winding engine, also constructed by Messrs. Fowler, has just been erected within the mine itself at a considerable distance from the surface. This engine has a pair of 16 in. cylinders, and it is fixed at the top of a boiler of the locomotive type, the waste gases and the exhaust steam being led off by a flue communicating with the ventilating shaft. We noticed near the mouth of the Skinningrove mine the parts of one of Mr. John Cooke's rotary ventilators lying ready for erection. This ventilator was illustrated and fully described by us on pages 269 and 271 of our eighth volume, and entertaining as we do, a high opinion of its merits we are glad to see that it is about to be tested on a large scale. After visiting the Skinningrove mine, and partaking of a lunch which had been provided, the party returned by special train to Middlesbrough.

Saturday was the last day of the meeting, and it was devoted to visiting works at Darlington, Hartlepool, Middleton and the Whitby Valley. Hartlepool and Darlington attracted the greatest number of visitors, and at each place there was much really worth seeing. At Hartlepool the principal works inspected were those of Messrs. Thomas Richardson and Sons, who are now steadily turning out compound marine engines at the rate of a pair every fortnight. These engines, which are of the two-cylinder type with intermediate receiver, are of an exceedingly neat and good pattern, designed by the manager of the works, Mr. J. Smith. As we intend to illustrate a pair of these engines in an early number, we shall not attempt to describe them here; but we cannot let them pass without bestowing a word of praise upon the manner in which they have been planned, so as to enable them to be constructed at a moderate cost, and at the same time to obtain thorough efficiency. The boilers made by Messrs. Richardson for use with these engines are all of the cylindrical type, fired from both ends, the furnaces communicating with a central uptake from which the tubes return to the ends of the boiler. These boilers are found to do a good duty, and, provision being made for the admission of air at the bridge, they answer well for burning north country coal. The boilers are butt-jointed and double rivetted, both inside and outside covering strips being used at the longitudinal seams. A noticeable point about them also is, that instead of the end plates being flanged over around their peripheries to meet the barrel, the barrel plates are flanged inwards to meet the end plates, the latter being kept flat. With boilers from 10 ft. in diameter and upwards, this flanging in of the barrel plates can be performed with far less labour than a flanging of the end plates, and less "work" is thrown upon the iron. At Messrs. Richardson's a special furnace is used for heating the plates to be flanged, the latter, after being bent to the curve of the boiler barrel, being hung so that the part to be heated lies in the fire between two pairs of tuyeres. The heating appliances are, of course, conveniently arranged with respect to the block for bending. The rivetting is performed at Messrs. Richardson's by means of one of Cook's steam rivetters, and the boilerwork turned out is altogether of a very creditable kind. Besides their marine-engine works and rolling mills, Messrs. Richardson have also extensive foundries, from which they are now turning out, amongst other work, 100 tons of cast-iron railway sleepers per day. At the time of our visit the foundries were principally employed on sleepers, of Mr. Livesey's pattern, for tramways at Buenos Ayres, and excellent sleepers they are. One we saw tested stood, before cracking, eight blows from a tup weighing 3¾ cwt., and falling 10 ft., this tup striking on a bar placed on the sleeper in the place which would be occupied by the rail, and resting on the pieces of wood lying in recesses in the sleeper, and the latter being itself bedded in loam. The resistance offered by this particular sleeper was certainly somewhat exceptional, but it was a common thing for the sleepers to resist three or four such blows before fracture. Of course in producing these sleepers machine moulding is resorted to, and an arrangement is adopted which, although not peculiar to Messrs. Richardson's works, we may notice here. This arrangement is as follows: At different points in the foundries are laid down elliptical lines of about a foot gauge, and on these lines run the moulding boxes for the sleepers, the lower halves of these boxes being provided with wheels. On one side of the ellipse the bottom halves of the moulds are rammed up on carefully prepared metal patterns, and they are then passed on to a point where they receive the cores and the top boxes, the latter being rammed up in the centre of the space enclosed by the elliptical line. Being then again passed on they arrive at a point where the metal is poured, and then a few minutes being allowed for setting, they are passed on to a point where the castings are withdrawn, while, finally, they complete the circuit, and reach their starting point, where they are refilled. Under these circumstances, when in regular work, the moulding boxes are continually progressing round the elliptical circuit, and the various operations follow each other so rapidly that each pair of boxes is used over and over again from three to four times per hour. As we have already said, however, our space does not permit us to describe in detail any of the establishments visited, and we must, therefore, take leave of Messrs. Richardson's works, and content ourselves by stating that, amongst the other establishments inspected at Hartlepool were the shipbuilding yards of Messrs. Withy, Alexander, and Co.; and Messrs. Denton, Gray, and Co.; and the works of the Hartlepool Malleable Iron Company, &c.

At Darlington the only works we ourselves had the opportunity of visiting were the Shildon Engine Works, belonging to the Stockton and Darlington section of the North-Eastern Railway. These works include a fine range of shops laid out in accordance with the most modern practice and containing a number of remarkably fine tools adapted for locomotive work, the whole being driven by a pair of side-lever engines (formerly we believe employed in the neighbourhood as winding engines) fitted with surface condensers. Amongst the special "dodges" about the works, we noticed a very handy little tool for turning up crank pins without removing them from the wheels. This machine is fixed to the wheel itself, being set fair by a centre entering the end of the crank pin, and the turning up is then effected by a tool which is carried round the crank pin, and which has the necessary feed-motion imparted to it. Another very handy tool is that employed at these works for refacing valve faces, the facing being performed by cutters, which revolve round a centre, while the latter is moved slowly across the face. The facing tools thus make a series of circular cuts overlapping each other, and we should expect that the work turned out will be very good. Amongst the tools also we noticed one of Justice's dead-stroke spring hammers, of the performance of which we heard favourable accounts.

Much of the traffic on the Stockton and Darlington line and its branches is of a very heavy character, and Mr. Bouch has lately designed and built some exceedingly fine six-coupled goods engines for working it. These engines include many features which render them worthy of special notice, and we hope shortly to be able to lay a complete account of them before our readers; meanwhile we may say a few words concerning them. Amongst other special details these engines are fitted with an arrangement of steam counter-pressure brake, designed by Mr. Bouch, and which he has used extensively with much success. According to these plans the ordinary cylinder cocks are done away with, and the four ends of the two cylinders are connected by pipes with a three-way cock placed centrally beneath the smokebox. This cock also communicates with the exhaust and with a pipe which tends backwards, and ultimately opens into the tender tank, while it also communicates with the warming cock. This arrangement serves several purposes. Thus, in the first place, it enables a portion of the exhaust steam to be discharged into the tender tank for heating the water; secondly, it enables the mixed steam and water which is ordinarily blown out of the cylinder cocks when the latter are open to be returned to the tender; and, finally, when the engine is reversed it enables steam to be admitted to the cylinders against the piston, the communication with the exhaust and with the tender tank being in this case shut off, and the warming cock partly opened. The engines, of which we are speaking, are also fitted with an arrangement of feed water heater well worthy of notice, this heater being formed by making the chimney with a double casing, and providing the smokebox with a double top. When this heater is in use, the water is drawn from the tender tank by one of the pumps with which the engine is provided, and is discharged through an annular rose situated within, and at the top of, the double chimney. The water is thus discharged in a finely-divided state amongst a portion of the exhaust steam, which is led into the heater through a suitable branch, and the water thus heated falls down into the chamber formed by the lower part of the chimney casing and the false top to the smokebox. From this chamber it is drawn by a second pump, and forced into the boiler. A glass gauge at the side of the chimney enables the driver to keep the water in the heater at the proper height, and the whole arrangement is very simple and efficient. Of the valve motion adopted by Mr. Bouch, we have already spoken, and we may add that throughout his engines great care is taken to provide ample bearing surfaces. We much regret that the length to which this notice has already extended does not permit us to speak more fully of the Shildon Works, or to describe the Stockton and Darlington locomotives in greater detail. We hope, however, at some future time to have an opportunity of making up for our present omissions, and meanwhile we may conclude by stating that we believe there is no rolling stock in the kingdom possessing more points of interest for locomotive and carriage superintendents than that on the old Stockton and Darlington Railway.

THE "WATERSTAAT" OF HOLLAND.

No. II.

HAVING for basis the principle that a regular and disinterested management of the Waterstaat was of paramount importance, and that, by such alone unity in plan and execution, with its wholesome consequences, could be secured, the first organisation was a bold step taken in the control of all that concerned the department; since, by it, not only were all the works undertaken at the national expense brought under the control of the members of the Board, but the superintendence of all dykes, watercourses, dyke boards, peat digging undertakings, &c., was placed in their hands; so that everything having reference to the Waterstaat was considered the care of the nation.

Thus, from 1798, the Institution of the Waterstaat may be said to date. It has undergone several modifications. To trace it through those modifications in four periods is our present object.

The first period from 1798 till 1817, when F. W. Conrad, the younger, first entered the service. The second from 1817 till 1830. The third from 1830 till 1849, and the fourth from 1849 till 1870.

In consequence of the *coup d'état* of the 12th June, 1798, which put an end to the Executive Government, as well as to the Representative Assembly, though without overthrowing the newly adopted constitution, the definition of the instructions designed for the guidance of the agent (minister), who was to have charge of the Waterstaat, was deferred till December of the year following, and not issued by the executive till February, 1800.

By them three sorts of works were distinguished. 1. Those undertaken and maintained at the national cost, and those to which private landowners had contributed, these were placed under the immediate control of the agent. 2. Those done and maintained at the expense of private persons, but subject to the approval of dyke-motes, were only under the superintendence of the agent. 3. Those subject to no approval, and over which no superintendence was held.

Besides, these instructions prescribed the appoint-

ment of a Commissaris-Inspecteur for the control of the Waterstaat; hence the necessity of a second organisation, which was resolved on, on the 26th July, 1800. By this a Commissaris-Inspecteur-in-chief was appointed, with fifteen Commissarissen-Inspecteurs, whose duties were distributed over five districts, viz., in the districts of the rivers Ems and Old Yssel two, of the Rhine two, of Amstel and Texel four, of Delf and Bommel and a part of the Schelde and Maas four, besides Brunings, who did duty in that of Amstel and Texel also. Of the Schelde and Maas three, Brunings was Commissaris-Inspecteur-in-chief.

The tendency to centralisation which characterised the former period abated, a reaction followed, and much power and influence that had been taken from the Departmental Governments was restored to them. These modified opinions had much influence on the Waterstaat. The works affecting the canals or flowing rivers of the country, their safety and traffic, in which more than one department was concerned, remained under the general Government of the republic. Of those works an inventory was kept, the other works were placed under the control of the Departmental Governments, who had to provide for their maintenance. In the last all works, those of the Departmental Governments included, were submitted to the orders of the Government of the State. The consequence of this was, the third organisation of the Waterstaat.

The new order of things, however, required time for its introduction. In August, 1802, the Commissarissen-Inspecteurs were maintained though provisionally only, but placed under the orders of the Departmental Governments, so far as the works under their superintendence were concerned, at the same time the office of agent for the superintendence of the Waterstaat was abolished, and his duties also provisionally confided to a board of the Home Office; which, on the 3rd of October, 1803, was discharged, and in consequence of a resolution of the ministry of the States (2nd September, 1803), two committees of superintendence were appointed, who together formed a permanent board for:

1st., the rivers. 2nd, the sea harbours and channels. Both committees were composed, at first, of a chairman appointed by the Government from their own body; and afterwards, that for the rivers, of a member of the Home Office and of nine or ten members to be appointed by the Departmental Governments for Holland, Guelderland, Utrecht, Over Yssel, and Braband. And that for the sea harbours and channels, of a member of the Board of Admiralty, and from four to eight members appointed by the Departmental Governments of Holland, Zeeland, Friesland, and the town and province of Groningen.

The members of these committees were not to be chosen from among officers in the service of the Waterstaat. Under these two committees of superintendence, the officers of the general service of the Waterstaat were placed. The labours of the committee for the rivers were distributed over two districts, each having two inspectors, that for the sea harbours and channels over four districts, each having one inspector. The staff of the general Waterstaat, of the Batavian Republic, under the two committees, was composed of one director-general, one clerk attached to the director-general, eight inspectors, three land surveyors, two assistant land surveyors, six upper surveyors, twelve surveyors and sub-surveyors, three fascine (kribben) workmen, one treasurer, one keeper of the gauge lists, in all, thirty-eight officers. Besides these were several officers of the Waterstaat engaged by the Departmental Governments under various titles, so that the total amounted to seventy-four officers of the Waterstaat. This gave rise to two classes of officers of the Waterstaat. These two committees of superintendence met only twice a year; with which arrangement a constant superintendence was incompatible. They were dissolved on the 1st of May, 1805, by a Government resolution under the Grand Pensionary Rutger Jan. Schimmelpeninck, and the control of the Waterstaat over the rivers, and over the sea harbours and channels was confided to a board of superintendence composed of the Secretary of State, as chairman and four members to be appointed by the Grand Pensionary, who were to meet the members, deputed by the Departmental Governments twice a year, but meeting once a fortnight for the despatch of business. On account of the modifications resulting from this resolution, the fourth organisation of the Waterstaat took place.

About this time, the director-generalship of the Waterstaat became vacant by the death of C. Brunings. During the rule of Schimmelpeninck, the office was not filled; but by a decree of the 10th of June, 1805, the duties of it were confided to two inspectors, one from the department of rivers, and the other from that of the sea harbours and channels, an arrangement which by no means tended to promote the unity aimed at by the committee of superintendence. In the evening of the 16th of May, 1806, at the Hague, whither he had gone to be present at the first deliberations of the committee just mentioned, C. Brunings died suddenly in the arms, literally of his pupil and friend, F. W. Conrad, the elder. From 1764, when after the death of van Noppen, he was appointed overseer of Rhineland, and the dyke and sluices at Spaardam, he had been the chief hydraulic engineer of his time. In 1766, he was engaged in an important inspection of the lakes of Haarlem and Leyden, and to give his advice on the imperfect state of the Waterstaat, of Rhineland, and the dangerous enlargement of the lake of Haarlem. He was principally instrumental in the improvements brought about by the distribution of the waters of the higher rivers; while so engaged, he invented an instrument (rheumameter) by which the average speed of the current at any section of a river can be ascertained. His plans for counteracting the choking up of the Yssel, and obtaining greater depth for the navigation at Amsterdam; his share in the new harbour at the Niemvediep; what he did with regard to the peat digging undertaking in the Krimpenerwoard, and the draining of that tract surrounded by the rivers Lek, Yssel, and Maas; his securing the sea beach from the mouth of the Maas to the Hondsborche, near Pettin; the draining of the pools near Niennkoop and Zevenhoven, the works at Hellwoet, in 1798, and the part he took in the plan for draining the lake of Haarlem, have established his fame. This period of this committee was characterised by the important act of 24th of February, 1806, containing a general law on the rivers and streams of the republic which is still in force, and is of great use by defining the rights and working of the superintendence.

After Louis Napoleon was proclaimed King of Holland, a royal decree was issued by which to secure as much unity and unanimity in the administration as possible, the existing state of things was to be superseded by a director-general of dykes, bridges, and roads, assisted by a permanent council, and by one or more inspectors-general. A committee was appointed to inquire into what existed in France of this kind, what had been done, and what there was to be done in Holland. After this inquiry had been made by virtue of a royal decree (20th of January, 1807), the general administration of the Waterstaat was regulated, from which resulted the fifth organisation of the Waterstaat.

The general administration was composed of one director-general, five members, one secretary-general, and one inspector-general. The director-general was A. Twent, the inspector-general, F. W. Conrad. By this the committee of superintendence was superseded. The other officers kept their places and were included in the general administration. After the death of F. W. Conrad, (February 6th, 1808), his place was not filled by *one* person, but two inspectors-general were appointed, J. Blanken and A. F. Goudriaan. The Waterstaat was not now a separate department of the state nor was it attached to the Home Office, but by a royal decree (January 21st, 1802), the general administration of the Waterstaat was superseded, and the Home Minister made director-general, supported by a committee of theoretical and practical men termed the central committee. By this, however, the business proper of the Waterstaat was not changed; but by a royal decree (May 22nd, 1809), the Waterstaat was again made a separate department with A. Twent at its head.

(To be continued.)

CHILIAN RAILWAY.—The San Felipe and Llaillai Railway was expected to be opened for traffic last month. The continuation of the line as far as Los Andes was to be commenced as soon as the surveys and plans were finished. The portion of the Chilian and Talcahuano Railway between Talcahuano and Malvoa was expected to be ready for general traffic early next year. The Chilian Government has invested largely in railways, but they are expected to prove fairly productive.

NOTES FROM PARIS.

PARIS, July 30, 1871.

RAILWAY TRAFFIC.

THE different railway companies have recommenced the publication of their weekly receipts, and the tabular statements show an excess of receipts over those of the corresponding week of 1870. On several lines the first six months of the current year is also in excess of the first half of the last year.

THE CREDIT FONCIER.

The Credit Foncier has suffered less than was feared from the terrible crisis through which we have passed. It will declare this year only a very small dividend, but the report of the general meeting of shareholders announces that the position of the company is entirely satisfactory.

THE GENERAL CONVEYANCE COMPANY.

The General Carriage Company held its meeting on the 27th ult. The number of horses has decreased from 9620 in 1870 to 3051, and the agents of the company are actively occupied in filling up the deficiencies by important purchases. The traffic receipts of 1870 were about 14 millions of francs, about 2½ millions less than in 1869. The dividend has been fixed at 10 francs per share.

TRANSPORT.

The insufficient means of transport continue to occupy the attention of producers, merchants, and consumers. The National Assembly and the Administration have adopted many measures for improving the unfortunate situation. Those companies most pressed with business must of necessity hire rolling stock from less occupied lines, and will have to call in the aid of coasting vessels; the State places at the disposition of trade many transport ships of heavy tonnage, and instructions have been sent to the companies on the different means of increasing the transport of merchandise.

THE DANGERS OF GASHOLDERS.

There are often many discussions provoked on the dangers incurred by the proximity of gasholders. Upon this subject some interesting facts were observed during the siege. Two gasholders had been struck by shells, the one at Ivry, the other at La Villette. In the first case the gas ignited, and burnt during ten minutes, with a mass of fire, which disappeared for want of material when the holder was empty. During this conflagration the top of the holder sank upon its supports, absolutely as if it were furnishing gas to the city in the ordinary course of business. There was no explosion, no other damage than the holes made by the shells.

At Villette a shell pierced and burst within a gasholder, liberating the gas; the fragments of shell perforated the plates in nine points. Under the pressure of the dome of the holder the gas escaped into the air through the openings, and it would have entirely disappeared, as at Ivry, if the workmen had not immediately stopped the apertures. Here no ignition, and, *a fortiori*, no combustion occurred, and no damage beyond the rupture of the plates.

THE LATE M. PAYEN.

France has recently lost one of her most eminent chemists, M. Payen, who died, on the 13th of May, of apoplexy. M. Payen was professor of industrial chemistry at the Central School since 1830, and at the Conservatoire des Arts et Métiers since 1839, a member of the Institute since 1842, and was one of the men who have rendered the greatest services to industrial and agricultural chemistry by the immemorable labours which adorned his long career. We may notice, amongst others, his researches into animal manure, on disinfection, on the elementary composition of starch and gums, on acetates, on beetroot and cane sugars, on india-rubber and gutta-percha, on fatty matters, and on paper. These, and many other works published in scientific periodicals, in books, and in a large series of pamphlets, are daily used in all the industries to which they refer, and have powerfully contributed to the marvellous progress in which the application of chemistry during the past twenty years has so wonderfully contributed.

CONGELATION OF WATER.

M. Boussingault communicated, at a recent séance of the Academy, a report of some curious experiments that he made on the congelation of water during the rigours of the past winter. It is, of course, known that water, in freezing, tends to dilate with very considerable force, equal to that which would be necessary to apply to ice to reduce its volume 8 per cent. The historical experiments of the Academician of Florence and those of Hughens, in 1667 are very familiar. M. Boussingault proposed to seek, by experiment, if, in opposing to the dilatation of the water a sufficient force, freezing could be prevented at very low temperature. He took a cast-steel cylinder, 18 in. long and 1½ in. diameter, and in it was drilled a hole ½ in. diameter 9½ in. deep. The end of this tube could be hermetically closed by a screw joint. It was cooled down to a temperature of 39.20° Fahr., and filled with distilled water of the same temperature. It was then hermetically closed, after a small fragment of steel had been introduced. The apparatus was then exposed to the following temperatures: 8.60°, 10.40°, 15.80°, and 11.20° below zero, and at each trial it was possible to tell by the movement of the steel fragment that the water was unfrozen. The water froze instantly when the pressure was removed. These experiments were afterwards repeated with precisely similar results. The results, which might have been foreseen, possess interest, however, and it would be worth while to repeat

the experiments, with a suitable apparatus, to ascertain the pressure brought against the sides of the tube, and also the exact pressure necessary to resist congelation.

THE BLAST FURNACE.

M. L. Gruner has undertaken some researches with the action of carbonic oxide on the oxide of iron. He has taken as a point of departure the facts published by Mr. Lowthian Bell, of Middlesbrough. In submitting the iron ores to the action of the gases in the high furnaces at a temperature of from 300 to 400 deg., they are seen at the end of some hours, not only to be reduced partially, but also to be covered with floculent carbon, to fall in powder, and to increase in volume. The proportion of carbon thus deposited reaches 20 and even 25 per cent. of the weight of the mineral. The same effect is produced by pure carbonic oxide at this temperature of 300 or 400 deg., although in working at a red heat, there would never be any carbon deposited, neither with the pure carbonic oxide, nor with the gases of the blast furnace. Such are the facts stated by Mr. Bell.

M. Gruner has made, moreover, experiments in studying these facts, and the following are the principal conclusions he has drawn from his trials :

In passing the same gas over metallic iron at the same temperature, this iron becomes equally covered with powdered carbon, but this phenomenon is attributable to the existence of traces of carbonic acid, or of bodies containing oxygen capable of transforming into carbonic acid a part of the carbonic oxide, for it is produced, more or less, when the iron is not free from all mixture of oxide.

These deposits of carbon appear to be of ferruginous carbon, holding from 5 to 7 per cent. of iron, similar to certain graphites in which the presence of iron is indicated. This deposit is only produced when there is with the iron the protoxide of iron. The carbonic oxide becomes partially converted into carbonic acid by the deposition of carbon, the carbon fixing itself on the iron and the protoxide retaining the oxygen, but this reoxidation is only reproduced when the reducing action of the carbonic oxide is partially affected by the carbonic acid.

The pure carbonic oxide is not changed by iron deprived of all traces of oxygen. In the same way carbonic acid, if it acts only on iron, gives no deposit of ferruginous carbon.

If the temperature is raised to red heat, the deposit soon ceases, and even the carbon already deposited is consumed. Regarding blast furnaces, it is in the upper part that the carbon should be deposited with minerals, and this deposit, by its internal mixture with the oxide of iron, ought to facilitate the ultimate reduction of the minerals and that of the carbonic acid.

THE PRESIDENT OF THE BRITISH ASSOCIATION.

THE Council of the British Association showed a wise judgment in selecting Sir William Thomson as the President for the present year. In profound mathematical acquirements, and in the mathematical treatment of physical questions, Sir William Thomson stands almost, if not quite, unequalled among living philosophers; and he has many claims upon the members of the British Association, if we bear in mind that the chief object of that institution is to give active encouragement to the prosecution of research in the physical as well as in the so-called natural sciences.

Sir William Thomson was born in the year 1824, in the town of Belfast, where his father, Dr. James Thomson, was a professor of mathematics, and whence he removed in 1832 to Glasgow, to occupy a similar position in the University of that city. After proceeding so far with his education in Glasgow, he went to Cambridge, where in his twenty-first year he graduated as second wrangler, and Smith's prizeman in 1845. His brilliant preliminary career was marked by his election to the fellowship of St. Peter's College, and at the age of twenty-two years he was elected to the Professorship of Natural Philosophy in the University of Glasgow in succession to the venerable Dr. Meikleham, a position which he has now held for a quarter of a century, and in which he has become a leader of thought in one of the highest walks of science. His eminence as a mathematician led to his being appointed to the editorship of the *Cambridge Mathematical Journal* before he finished his University career, and in that capacity he was brought into close communication with the most profound mathematicians, both at home and abroad, many of whom contributed to the pages of the journal which he edited. While at Cambridge he devoted a great amount of attention to the study of electricity, and especially to the mathematical theory of that branch of physical science; and it was his profound knowledge of the laws and phenomena of electricity and magnetism that led to his professional connexion with the Atlantic Telegraph Companies. As is well known, the earliest of these undertakings was attempted in the year 1858, when there was a temporary success, but only such a success as demonstrated the practicability of the enterprise. The final triumph in 1866 is also well-known. That triumph was due in great part to the invaluable scientific advice of Professor Thomson, and to the incalculable aid which his extraordinary instrumental appliances brought to bear upon the labours of those who were engaged in the undertaking. As an acknowledgment of the untold value of those services he had the honour of knighthood conferred upon him shortly after the conclusion of the labours of 1866.

Sir William Thomson's scientfic honours are not few. Amongst them we may include the fellowship of the Royal Society of Edinburgh, and the Royal Society of London; Keith prizeman of the Royal Society of Edinburgh in 1861; Bakerian Lecturer in 1855; D.C.L. of Oxford, and LL.D. of Trinity College, Dublin, and of the Universities of Edinburgh and Cambridge. His scientific papers are so numerous that a large portion of our space would be required to enable us to give their titles and the merest analysis of the subjects upon which they treat. Amongst his intimate co-workers, there are Professor G. G. Stokes of Cambridge, Professor P. G. Tait of Edinburgh, Dr. J. P. Joule of Manchester, Dr. Mayer of Germany, Professor W. J. M. Rankine of Glasgow, and many other *savans* holding somewhat similar positions in the ranks of physical science. Of the great grasp of mind possessed by Sir William Thomson, a careful perusal of the presidential address delivered before the British Association at the Edinburgh meeting of 1871, will afford ample testimony.

THE HIGHLAND AND AGRICULTURAL SOCIETY OF SCOTLAND.

THE forty-fourth annual show of this society was held last week in Perth, on Wednesday, Thursday, and Friday. The Highland and Agricultural Society of Scotland is the parent society of its kind, both the Royal Agricultural Society, whose annual show was recently held at Wolverhampton, and the Royal Irish Agricultural Society, having had their origin much more recently than 1822, when the first show of the Scottish Society was held. At first, and for four years successively, the annual shows of this society were held in Edinburgh; then they were held in Glasgow and Edinburgh alternately; and in the year 1829 and thenceforward the provincial cities and towns of the northern kingdom were brought in to divide the honours with Edinburgh and the commercial metropolis in the west of Scotland. The first provincial meeting was held in Perth, and including it and the meeting of last week there have been five shows held in that city.

The entries in the implement and machinary department were 1948, while the four years immediately preceding they were as follows:—Glasgow (1867), 1344; Aberdeen (1868), 1158; Edinburgh (1869), 1900; Dumfries (1870), 1873; and thus the Perth show of 1871 stands highest in this department, and if the late applications in the several departments had all been accepted by the secretary, this year's Exhibition would have been the largest ever held under the auspices of the Highland and Agricultural Society of Scotland.

In the machinery in motion section there were fully fifty entries. The Dunston Engine Works Company, Gateshead-on-Tyne, exhibited in this section one of Archer's new patent stone breakers. Messrs. H. R. Marsden and Company, Soho Foundry, Leeds, exhibited one of Blake's stone-breaking machines. In the same section Messrs. John Fowler and Company, Steam Plough and Locomotive Works, Leeds, exhibited a 6-horse power traction engine which was driven round the show yard at intervals. The patent vortex turbine water-wheel as invented by Professor James Thomson, C.E., Belfast, and made by Messrs. Williamson Brothers, Kendal, was also shown. The same firm also exhibited a portable steam engine of 6-horse power. Portable steam engines of from 5 to 8-horse power were exhibited by Messrs. Clayton and Shuttleworth, Lincoln, together with an improved double-blast finishing thrashing machine and an apparatus for cleaning and bagging the chaff. Messrs. Robey and Company had a number of thrashing and finishing machines, and an improved straw elevator by means of which the straw, on being discharged from the thrashing machine, is delivered to the man in charge of the stack up to a height of 25 ft. Their 8-horse power traction engine ran to and fro in the show yard and attracted a good deal of attention.

Amongst the steam ploughing machinery there was exhibited one of the engines lately purchased by the Scottish Steam Cultivation and Traction Company from Messrs. John Fowler and Company, Leeds, at the recent show at Wolverhampton.

One of the most interesting implements exhibited at the Perth show was shown at stand No. 98 (Hunter of Maybole, Aryshire). It is an American invention, a revolving veist mould board plough, made at Mellard's Trent Foundry, Rugeley, Staffordshire. The Inspecting Committee recommended it for trial, as it seemed to be in the estimation of many persons quite the novelty of the show in the implement and machinery department, and it was accordingly arranged to have the trial on the farm of South Muirton, about a mile from Perth, on Thursday last. The construction of the plough is very simple. The mould-board is a circular piece of cast steel, about 20 in. in diameter, set at an angle where the mould of an ordinary plough is attached. As the plough cuts the furrow, the pressure of the latter drives the revolving board, which in its turn lays aside the furrow very quickly, and thus the work done very much resembles that executed by the spade. It is also provided with a skim which insures the burying of the surface most satisfactorily. By means of this implement the furrow is very much broken, in fact it is half cultivated. The ground on which the trials were made was part fallow and part lea land. On the former pretty good work was made, while the result on the lea land was not so good, but this may be due to the fact that the man who usually works the implement was not present at the trial. The Inspecting Committee resolved on subjecting the implement to a further trial and on testing it with the dynamometer. This was done on Friday under the inspection of the Implement Committee, Mr. Slight, the Society's practical engineer, tested the draught of the mould-board plough, and found it to be on an average equal to six cwt. as compared with four cwt. which was the draught of two swing ploughs that were tried along with it. The work performed by the new plough, however, was very satisfactory. A number of Scotch farmers have each secured one of the revolving mould-board ploughs, and are determined to give it a fair trial.

The double-furrow ploughs which Messrs. Pirie and company, Kinmundy, Longside, Aberdeen, devised and patented within the last few years, are still exciting a great amount of interest in the agricultural mind. Indeed, at the Perth show they formed quite a prominent feature among the objects exhibited.

Messrs. John Gray and Co., Uddingston, near Glasgow, who have attained almost as great an amount of celebrity in connexion with the double-furrow plough as the original inventors, also had a large display of ploughs, including nearly a dozen double-furrow ploughs, together with a triple-furrow plough, several single-furrow ploughs, a patent anti-friction plough, &c. The last-mentioned plough has a wheel instead of the sole, and owing to this improvement it can do with two horses the work of three yoked to an ordinary plough, the depth of furrow being the same in both cases.

Messrs. James D. Allan and Sons, Culthill, Dunkeld, also exhibited a double-furrow plough claiming to have a "radical improvement." It possesses double lifting levers which are so arranged that one furrow can be taken up and two down hill without stopping the horses. The same exhibitors had a ridging or drill plough, in which wheels are substituted for the sole or slade of the implement so that the motion may be more easily effected.

For excellence of workmanship in respect of the double furrow ploughs which they exhibited, Messrs. Jack and Sons, Maybole, and Messrs. Sellar and Sons, Huntly, Aberdeenshire, may be said to have borne the palm. In both cases the goods displayed were of first-rate quality. Various other firms who have gone into the manufacture of double furrow ploughs, in order to meet the great demand which has arisen for those implements, exhibited their goods in a more or less creditable manner.

Reaping and mowing machines were displayed in great numbers and in great variety as regards their structural peculiarities. All the well-known makers of such machines were represented at the Perth Show, including Kemp, Murray, and Nicholson, of Stirling; Law, Duncan, and Co., Shettleston, near Glasgow; Richard Bickerton and Sons, and Brigham and Co., both of Berwick-on-Tweed; R. Hornsby and Sons, Grantham; Lillie and Elder, also of Berwick-on-Tweed; Picksley, Sims, and Co., Bedford Foundry, Leigh, Lancashire; Samuelson and Co., Banbury; Walter A. Wood, and others. In a number of instances the machines exhibited claimed to be "new inventions" or to have "radical improvements" embodied in their construction.

Bisset and Sons, Blairgowrie; Law, Duncan, and Co.; James Mollison, of Meigle, Methven; James Robertson, of Coupar-Angus, and others exhibited potato digging machines in some of which there were some features of construction worthy of commendation. In weighing machines the chief exhibitors were Messrs. A. and W. Smith and Co., Eglinton Engine Works, Glasgow, who have long made a speciality of this branch of business, and have deservedly acquired a first-class position in it. Messrs. Benjamin Reid and Co., exhibited, among other things, their patent sixteen-row fixed coulter, Aberdeen prize disc drill, which sows 4 in. apart, and is specially adapted for small occupations. This implement was invented and made by the exhibitors, and lately took the first prize at a trial of drills in Belgium, beating the famous French drill of Jacques-Roubillard.

PRIVATE BILLS IN PARLIAMENT.

THE Committees of both Houses have now well nigh concluded their labours for the present session, so that our reports have become narrowed down to the bare records of third readings and Royal assents. On Monday last the following Bills received the Royal assent by commission, the Commissioners being the Lord Chancellor, the Duke of St. Albans, and Earl Cowper: The Sligo and Ballaghaderreen Junction Railway, the Birmingham West Suburban Railway, the Bury Port and Gwendreath Valley Railway, the Great Western (Bristol and Exeter and South Devon) Railway Companies, the Killorglin and Farranfore Railway, the North Metropolitan Tramways, the Waterford, New Ross and Wexford Junction Railway (No. 3), the Ennis and West Clare Railway, the Great Western Railway, the Kent Coast Railway, and the Leominster and Kingston Railway Bills.

The third readings have been, in the House of Lords, the Waterford, New Ross, and Wexford Junction Railway (No. 3), the Midland and Great Eastern Railway (Alexandra Park Branch), the London and Aylesbury Railway, the West Lancashire Railway, and the Mersey Docks and Harbour Bills.

Before the House of Commons Committee on the Isle of Wight, Cowes, and Newport Railway Bill, the Committee decided that further time should be given to test the *bonâ fides* of the authorised Isle of Wight and Newport Junction Railway with respect to the completion of their works. They were, therefore, of opinion that the preamble of the Bill was not proved.

On Tuesday before the House of Lords Committees the preamble of the unopposed Mersey Docks and Harbour Board (No. 2) Bill was passed. The preamble of the Waterford, New Ross, and Wexford Junction Railway Bill (No. 3) was also passed and reported without amendment. This is a Bill to extend the time for the construction by the Waterford, New Ross, and Wexford Junction Railway Company of their railways between Ballywilliam and New Ross, authorised by the Waterford, New Ross, and Wexford Junction Railway Act, 1866, and the Waterford, New Ross, and Wexford Junction Railway (Deviation) Act, 1867. The preamble of the last opposed Bill of the Session was also proved and Bill reported with amendments, viz., the Newry Borough Improvement and Water Supply Bill. The object of this Bill is to empower the Town Commissioners of Newry (*inter alia*) to purchase Halliwell's Water Works, to construct new water works, and to supply the Town of Newry and neighbourhood with water. In support of the Bill Mr. T. Hawkesley was examined and cross-examined at great length. The capital proposed to be raised is 20,000*l.* by loan.

HYDRAULIC PRESSURE CRUSHING MILL.

DESIGNED BY MR. JOHN WITHINSHAW, ENGINEER, BIRMINGHAM.

FIG. 1.

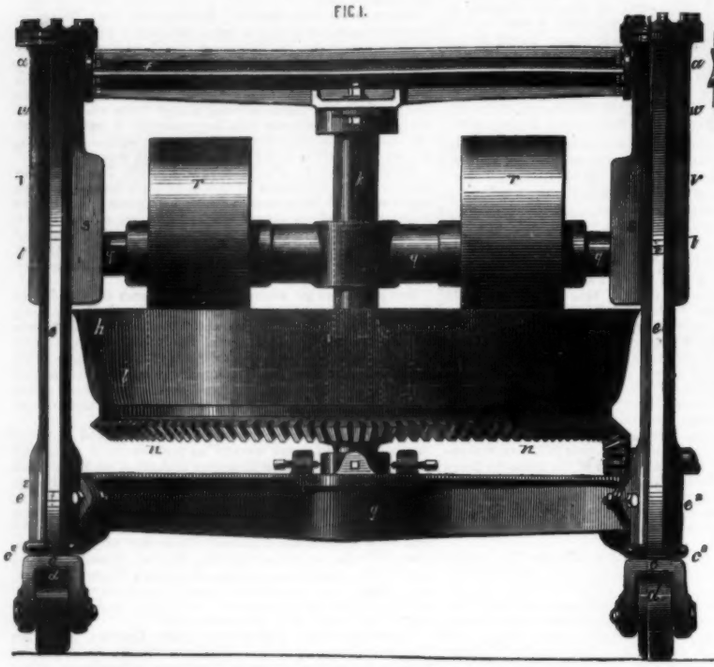
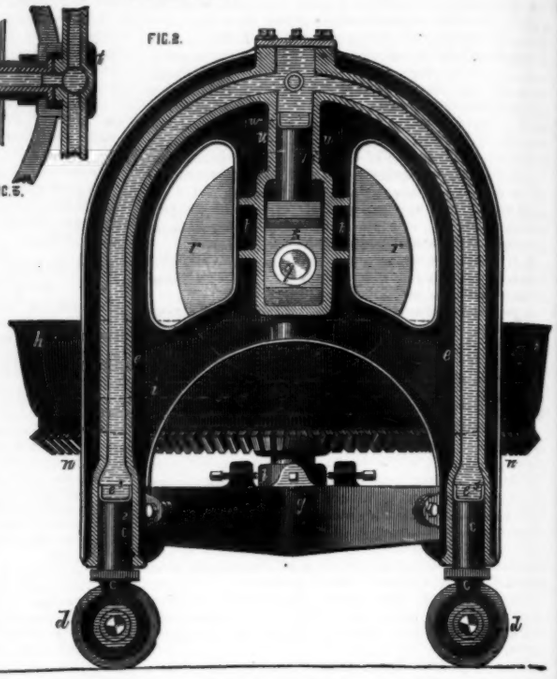


FIG. 3.

FIG. 2.



THE accompanying illustration shows an arrangement of crushing mill, designed by Mr. John Withinshaw, of Birmingham, for adoption in those mills which consist of a rotating platform or table on which the material to be crushed is placed, with rotating rollers bearing on the table. The object of the arrangement is to obtain great crushing power without the employment of very heavy stones or crushers. In the drawings Fig. 1 is a side elevation, and Fig. 2 a section through the framing of the mill.

The four supports of the mill upon which the whole of the framing is carried are shown at c, c. These supports when the mill is portable are carried by the rollers, d, d, upon which the mill may be moved at pleasure. The end, c^2, of the supports, c, c, are made into pistons, each piston being provided at the top with a cupped leather packing, c^3. The framing of the mill consists of four uprights, e, e, having arched tops, each pair of the said uprights being connected together by the cross head, f. The bottom of the uprights, e, e, are connected together by the diagonal bed or foundation plates, g, bolted to the uprights. Each pair of uprights, e, e, together with the journal or box for receiving the end of the roller shaft and the hollow cylinder of the bearing piston are made in one piece. The four uprights, e, e, their arched tops, and the cross head, f, joining them are hollow. The bases, e^1, e^2, of the upaights are made into short hollow cylinders which fit upon the pistons, c^2, c^2, of the supports, c, c, and work water-tight upon the pistons by means of the cupped packings, c^3. The four uprights, e, e, and the cross head, f, constituting the hollow framing of the mill are filled with water under pressure by means of an hydraulic pump connected with one of the uprights, and all the parts of the mill except the fixed supports, c, c, are supported on the water between the pistons, c^2, and the tops of the cylinders, e^1, of the uprights, e. By increasing the quantity of water forced into the cylinders, e^1, the whole mill rises, and by diminishing the water the mill is allowed to descend. The pan, z, on the bottom or table, i, of which the matter to be crushed is placed, is shown in Figs. 1 and 2. It is connected to the vertical rotary shaft, k, which shaft is supported at bottom on the bearing, l, carried by the bed plates, g, and turning at top in a bearing at m, carried by the cross head, f. Rotation is given to the pan, k, i, by the bevel gearing, n, p; the horizontal shaft on which the rotating crushing rollers, r, r, turn loosely, is shown at q, the vertical shaft of the pan passing through an eye in the roller shaft. The peripheries of the crushing rollers, r, r, are made to bear upon the table, i, of the rotating pan, and have motion given to them by the table. A variable pressure of the crushing rollers, r, r, on the table, i, is produced, and the pressure of the whole mill transmitted to the crushing rollers in the following manner: The ends of the roller shaft, q, are fitted in blocks, s, s, which are capable of a rising and falling motion in the journals or boxes, t, t, carried by the sides of the hollow framing of the mill. The upper contracted parts, u, u, of the journals or boxes, t, t, constitute hollow cylinders, which are in communication with the cylinders, e^2, e^2, and hollow framing, e, e, f, of the mill, as shown. In each of the hollow cylinders, u, a piston, v, works, the broad base of which bears upon the block, s, of the roller shaft, q. The shape of the base of the bearing pistons, v, v, is seen in Fig. 1. The area of the two bearing pistons, v, v, of the roller shaft being less than the area of the pistons c^2, c^2, supporting the frame, it follows that the pressure of the whole mill is transmitted by the pistons, v, v, and by them to the shaft, q. The crushing rollers, r, r, are thereby pressed forcibly into contact with the rotating platform, i, and great crushing power obtained in the mill. In case any hard substance incapable of being crushed by the power of the mill be introduced between the rotating platform or table, i, and the rollers, r, r, one or other of the rollers rises or is canted. The block, s, of the roller shaft, q, is thereby made to act upon and raise its piston, v, the rising of the piston forcing the water from its cylinder into the frame supporting cylinders, e^2, and causing the whole mill slightly to rise. On the removal of the hard substance the parts of the mill resume their normal position.

RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 2227, 8d.) Thomas Symes Prideaux, of 209, Piccadilly, patents arrangements for admitting air to boiler furnaces, &c., the flow being governed by an automatic regulator. The plans may be considered as an improvement on those forming the subject of Mr. Prideaux's well known patent of December, 1853.

(No. 2235, 1s. 4d.) Charles Denton Abel, of 20, Southampton-buildings, patents, as the agent of George Westinghouse, junior, of Pittsburg, U.S., an arrangement of atmospheric railway brake. This brake has of late attracted much attention in the United States, but it appears to us to be inferior in simplicity and general applicability to Kendall's atmospheric brake, illustrated and described by us on pages 319 and 320 of our sixth volume. It would be impossible for us to give a brief description of Mr. Westinghouse's plans.

(No. 2242, 8d.) William Oliver Johnston, of Newcastle-on-Tyne, patents methods of casting flanged cast-iron pipes, columns, &c. According to these plans, the moulds are provided with accurately faced chill plates, placed so as to give the flanges of the columns or pipes chilled surfaces which shall not require any subsequent facing up. This system of casting pipes, &c., appears likely to be useful in many cases.

(No. 2255, 1s. 4d.) John Milroy, of Edinburgh, patents methods of constructing columnar piers or foundations of sections of concrete, brickwork, or stonework, lifted and deposited in place by a particular form of holder. These plans are worthy of the attention of contractors, but as we intend to describe and illustrate them in an early impression we need not enter into details concerning them here.

(No. 2257, 8s.) James Robertson, of Glasgow, patents appliances for bending and drawing metal plates into parallel or tapered tubes of various sections. Many of the arrangements included in this patent are very ingenious, but the plans are too voluminous for us to attempt to describe them here.

(No. 2258, 8d.) Thomas Brown, of Newgate-street, patents, as the agent of Charles Burleigh, of Fitchburg, U.S., an arrangement of air compressing machinery; which we certainly do not admire. According to this plan, two air compressing cylinders are used side by side, their pistons being connected to opposite cranks on one shaft and their upper ends being fitted with delivery valves opening into a single valve chest. The cylinders are arranged over the crank shaft, their lower ends being open; and the inlet valves are fitted to the pistons. Provision is made for introducing water between the pistons and the delivery valves; but the water thus admitted will, from the nature of the arrangement, be discharged in an objectionable manner each time the inlet valves open.

(No. 2274, 6d.) William Robert Lake, of Southampton-buildings, patents, as the agent of William Hunter Van Cleve, of Ypsilanti, U.S., a form of washer for locking the nuts of fish-plate bolts, &c. This washer is made by punching a piece of metal plate with a hole of such form, that projections or studs break the line of the circumference on opposite sides. These stud pieces are next bent up at right angles to the face of the washer, and in using the latter they are caused to enter the oblong hole in the rails at the points where its diameter is greatest. The washer is thus prevented from turning, and on the nut being screwed up against it, the washer is bent up against one of its sides. The idea is ingenious, but we think that in the hands of ordinary plate layers the locking action would be found to be far from secure.

(No. 2285, 1s. 6d.) Thomas Ivory, of Edinburgh, patents a form of rotary engine, which, except perhaps in some of the constructive details, appears to be practically identical with Mr. Beales's well-known engine brought out many years ago.

(No. 2294, 10d.) William Robert Lake, of Southampton-buildings, patents, as the agent of Ernest von Jeinsen and James Monroe McDonald, of San Francisco, U.S., a somewhat complicated arrangement of railway carriage axle-box, the leading feature of which appears to be that the oil is admitted to the journal at intervals by a valve which is opened from time to time by the concussions which take place when the vehicle is running.

(No. 2295, 1s. 4d.) James Howard and Edward Tenney Bousfield, of Bedford, patent improvements in the details of mowing and reaping machines, which are worthy of the notice of those interested in such matters, but which we could not describe briefly.

(No. 2296, 1s. 10d.) William Firth, of Rose-villa, Viewforth, Edinburgh, patents forms of elastic tyres for traction engines, &c. We could not describe these plans briefly.

THE LAMP STANDARDS OF THE THAMES EMBANKMENT.—The ornamental lamp standards on the Thames Embankment are now being bronzed by a new process, which is of French origin. It was originally intended to have done them by the ordinary process, but Mr. Vulliamy having seen some samples of bronzing by the French method, which involves chemical treatment, directed its application to the Embankment standards. The work is being carried out by Messrs. Mansfield and Co., of the Manor Iron Works, Chelsea, at whose foundry the standards, 134 in number, were cast.

BAUSCHINGER'S INDICATOR EXPERIMENTS ON LOCOMOTIVES.

(*Continued from page 51.*)

(*b*) *Admission.* The admission of steam into the cylinder depends, of course, in the first place upon the amount of regulator opening. We have, in Table III., on page 18 of the present volume, given the relative areas of these openings, and referring to the indicator curves published on pages 51 and 52 of our last number but one, it will be noticed that where the diagram was taken with the regulator practically open, the piston obtained nearly the full boiler pressure at the very commencement of the stroke. That this condition is more a question of lead than of anything else will be manifest by a glance at diagrams Nos. 3 and 9, engine (A), taken at the 2nd and 6th notch respectively. In the former case—the engine running near mid-gear—the lead amounts to 2.2 per cent. of the piston area, and, as shown by the diagram, the initial cylinder pressure was 98 per cent. of the pressure in the boiler; while in diagram No. 9, taken with a lead of but 1.6 per cent. of the piston area, the maximum cylinder pressure reached but 90 per cent. of the boiler pressure, notwithstanding the slower speed of the engine.

An important consideration in connexion with the admission of steam is that the maximum cylinder pressure be fully maintained until the closing of the valve; in other words, that the steam line of the curve traced by the indicator, should, as much as possible, run in a horizontal direction. To effect this, it is necessary to have the port fully uncovered early in the stroke, so that the steam can be rapidly introduced into the cylinder. Referring to diagrams taken from engine A at the 4th, 6th, and 8th notch, we find that the steam line is kept well up to the boiler pressure, and this pressure is nearly fully maintained until the point of cut-off is reached. If we take into consideration the small amount of lead obtained in these cases, we must attribute the comparatively good results solely to the employment of the Trick or Allen valve, the auxiliary steam passage of which permits—with a smaller amount of angular advance of the eccentric—a very rapid and good introduction of steam.

In diagrams taken with a high rate of expansion and more particularly at high speeds, the steam line generally falls more or less during the period of admission, indicating that the port opening is insufficient. Diagram No. 1, on page 52, illustrates a case of this kind, taken from the 1st notch of engine (A), while the engine was making 144 revolutions per minute. Although here the initial pressure attained nearly the boiler pressure, yet the quantity of steam admitted was not sufficient to maintain that pressure, even for part of the stroke; in other words, the steam is said to be wiredrawn or throttled.

The form of the steam line of the indicator curve depends, however, not only upon the more or less rapid opening of the steam port, but also on the maximum length to which the port is opened. Comparing the distribution diagrams on page 52, of the two different valve gears, it will be noticed that the Meyer double valve motion, having less angular advance of the eccentric and less lap of the valve, opens the port both more widely and quickly than the shifting link motion, and owing to this circumstance the initial cylinder pressure is fully maintained during the period of admission, for all degrees of expansion, as demonstrated by the indicator curves taken from engine (G). On the other hand, the same curves indicate a striking discrepancy between the boiler pressure and that obtained in the cylinder, but in this respect the diagrams under notice can hardly furnish conclusive evidence, since they were in most cases not taken with the full regulator opening; in this case, also, the pre-admission does not begin before the piston has reached the end of its stroke, a fact which is certainly very objectionable, even taking into account the slow working speeds of engine (G). In alluding to this fault of construction, we may just offer the general remark that we by no means approve of some of the proportions contained in Tables I., II., and III. (*vide* pages 1 and 18 of this volume respectively), which refer to the engines experimented upon by the learned professor. The Meyer motion, however, *can* be so proportioned as to offer the two desirable elements of a good admission, viz., attainment of the boiler pressure and the maintaining of this pressure during the period of admission; and Professor Bauschinger has in fact obtained some diagrams (at speeds above 100 revolutions per minute) from engine (E) which support our statement.

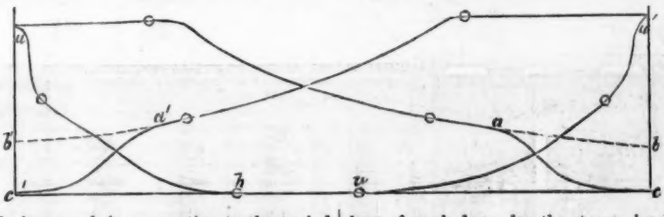
We have already seen that in the case of the shifting link motion the early pre-admission of live steam from the boiler and the amount of compressed steam tend to raise the cylinder pressure—at the very commencement of the stroke—within close approach of the boiler steam gauge, but with the ordinary slide valve this pressure can only be maintained at very slow speeds. If the engine is making above 100 revolutions per minute, the valve is unable to keep up the supply for any rate of expansion, and the steam line of the indicator curve begins to fall directly from the maximum cylinder pressure to the point of cut-off. In this respect the curves obtained from engines A and B, fitted with the double admission valve, compare very favourably with those of engines C and D, having the ordinary slide valve; the great advantages of the former valve being apparent even at the slow speeds at which goods trains are generally run.

That the maximum steam pressure obtained in the cylinder at the commencement of the stroke should remain as constant as possible during the period of admission, is very desirable, and we consider this property of the Meyer double valve motion practically of much more importance than any advantages which are often ascribed to this motion on account of the small compression. With the Stephenson link motion the same aim may be reached—and has already been reached in many cases—by the employment of the Trick or Allen valve with the auxiliary steam passage, and we certainly expect to find this simple and effective valve become in future more generally adopted.

(*c*) *Pre-release and release.* To provide a rapid egress for the steam, and in order that its pressure may be as nearly as possible at a minimum, after the work in the cylinder has been performed, it is necessary, that the exhaust port should be opened before the piston reaches the end of its stroke. The proper amount of this pre-release depends, of course, upon the velocity of the piston and the quantity of steam to be discharged, or the degree of expansion. If, on the contrary, the steam be confined till the last instant, the back pressure, at the commencement of the return stroke will be considerably increased, in proportion to the period of admission. The deficiency of pre-release produces in the indicator curves a sharp corner at the end of the stroke as shown by the curves obtained with the Meyer motion (engine G); referring to diagrams Nos. 17 to 19 of the series on pages 51 and 52 of the present volume, it will be noticed, also, that a considerable loss of effective pressure is caused for the same reason as clearly shown by the area cut off from the indicator diagrams. Judging from indicator experiments on stationary engines, it would appear, that in that case, a pre-release equal to $\frac{1}{4}$ of the port is sufficient. Referring now to Table No. II. on page 1, which records the amount and the beginning of the pre-release for the four Meyer valve gears, it will be seen that its highest value, for engines E, F, and G, is but $\frac{1}{7}$ of the port, an amount much too small, particularly when the higher working speed of locomotives, as compared with stationary engines, is taken into consideration. The amount of back pressure against the piston during the remainder of the exhaust, also, depends directly upon the amount of pre-release and, indirectly, upon the speed of the engine. If the exhaust port is not well open at the end of the stroke, it is evident, that the greater bulk of the steam must be discharged during the return stroke of the piston until the closing of the exhaust port; but as the piston attains its maximum velocity at half stroke, the minimum back pressure above the atmospheric line must then be greater than it would be under the more favourable condition of premature escape of the steam. Thus, defective pre-release involves not only a direct loss of the work done by the steam, as shown by the corner cut off from the indicator diagrams Nos. 17 to 19, but its injurious effect is also manifest during the greater part of the return stroke.

The condition of ample premature release of the steam can be satisfied in two different ways, first, by a diminution or, eventually, by an entire abolition of inside lap (as will be noticed by our illustrations on page 18, the valves of the locomotives of the Bavarian state railways are all furnished with considerable lap on the exhaust side); second, by increasing the lead of the eccentrics and the outside lap of the valve. Professor Bauschinger is of opinion, that, if necessary, the latter expedient should be employed, as the abolition of inside lap would diminish, at the same time, the compression, and thus injure, indirectly, the pre-admission of steam. By increasing the outside lap of the valve, on the other hand, the amount of maximum cylinder pressure during the admission will be somewhat prejudiced, but this loss will be more than compensated by the positive advantage of a free release and the freedom from back pressure; moreover, the consequent loss of pressure constitutes a lesser economical disadvantage since the quantity of steam admitted into the cylinder is, of course, of a less specific weight than the steam at boiler pressure. How far the condition of free release can be attained without injuring the other elements of the steam distribution we shall see presently by examining the shifting link motion; it will then be possible to arrive at data, which, in connexion with our former observations on the pre-admission, will lead to the proper construction of the main valve of Meyer's motion.

If we now consider the evidence of the indicator with reference to the diagrams obtained with the shifting link, it will be noticed that, some time before the piston has performed its stroke, the opening of the exhaust port is marked by a sudden fall of the descending curve. This leads Professor Bauschinger to the belief that the amount of pre-release is too much; in fact, the loss of effective pressure behind the piston is nearly equivalent to the corresponding gain due to the reduction of pressure before the piston on its return stroke. A striking illustration of this phenomenon is afforded by annexed diagram, taken in the second notch of engine B, while running into a station. Here, the



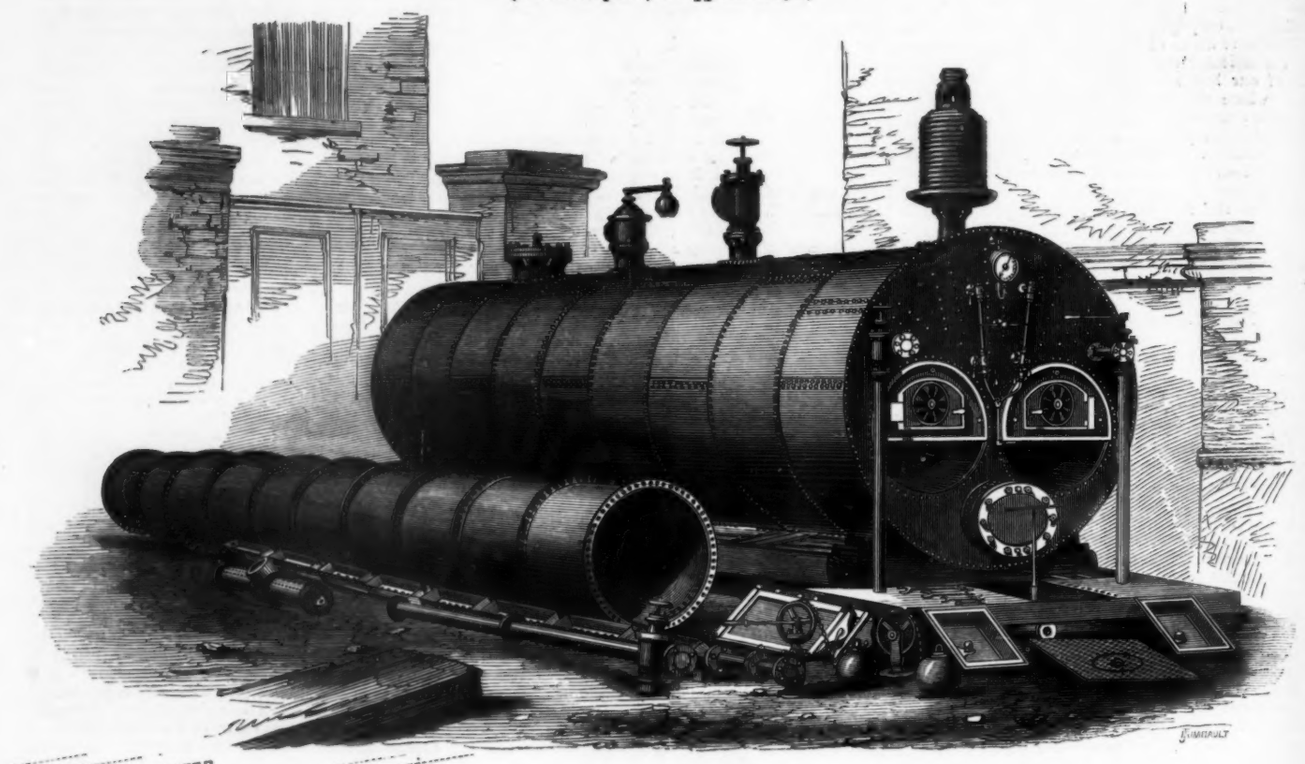
loss of work done, by the steam, is clearly shown by the areas, *a b c*, and, *a' b' c'*, cut off from the diagram by premature release; but during the return stroke, the back pressure against the piston becomes reduced to that of the atmosphere. It should be borne in mind, however, that this curve was taken under abnormal circumstances, viz., at a very slow speed, yet with a short cut-off. It is a marked feature of the shifting link motion that the release increases as the link approaches mid-gear, and this condition is necessary if the engine be run at a high speed which is generally the case in that position of the reversing lever; at starting, or in mounting a steep incline, on the contrary, a longer period of admission and a smaller amount of pre-release are usually employed. The influence of the

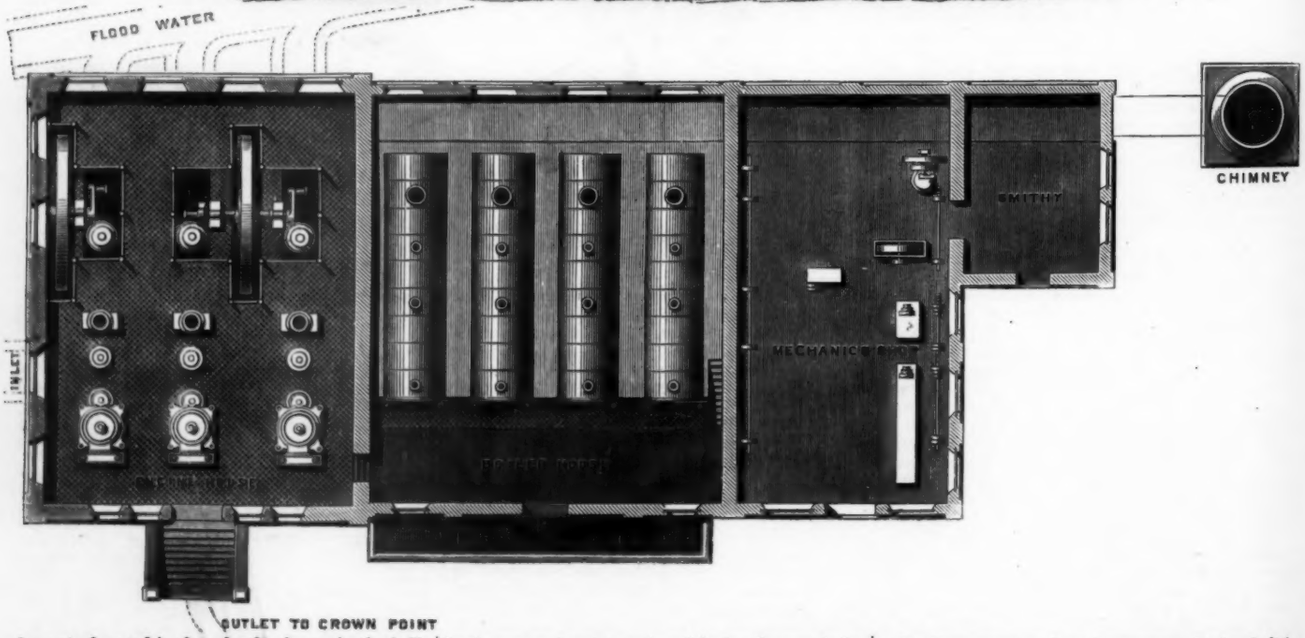
Class of Engine.	Notch.	Pre-release in per cent. of piston area.		Per cent. of stroke to be completed when pre-release commences.		Opening of exhaust port at end of stroke in per cent. of port area.	
		Hind end.	Front end.	Hind end.	Front end.	Hind end.	Front end.
A	8th	3.6	3.6	4	7	44	44
	2nd	4.5	4.5	20	25	55	55
B	8th	4.8	4.8	5	7	56	56
	2nd	5.9	5.9	25	35	72	72
C	6th	6.2	6.2	8	11	63	63
	1st	6.6	6.6	27	35	73	73
D	7th	4.3	5.7	6	10	55	75
	2nd	5.3	6.2	23	35	61	77

NORWICH SEWERAGE WORKS: BOILERS AND PLAN OF PUMPING STATION.

CONSTRUCTED BY MR. JOSEPH CLAYTON, ENGINEER, PRESTON.

(*For Description, see opposite Page.*)





element of speed is also clearly shown in the indicator diagrams. With increasing speed, the irregularities of the descending curve of the diagram become less apparent, and the change of the expansion line into that of the escape is much less distinct than at slow speeds.

But in order to appreciate the full importance of pre-release we should, at the same time, ascertain its influence upon the back-pressure line of the diagram. In this respect the indicator curves, taken from the various engines with the Stephenson link motion, furnish ample evidence to show that in the same measure as a free escape for the steam is provided for at the beginning of the return stroke, the back pressure becomes reduced during the remainder of the exhaust. As we have not considered it necessary to reproduce all the curves collected by the experimenters, we give, in the Table on the preceding page, some data respecting the pre-release of the different engines.

RUSSIAN RAILWAYS.—The Charkoff and Krementchug Railway has now been opened. The Kutais line, owing to the great engineering difficulties attending it, and the unusual number of bridges requiring to be constructed, will not be ready for some time to come. Several new lines have recently been projected, chiefly of a commercial description. The most important of these new lines is one between Yaraslave and Kostroma *vid* Nerechta.

THE INSTITUTION OF CIVIL ENGINEERS.—During the last three months the changes which have taken place in this, the only incorporated society of engineers in the United Kingdom, include the election of four members and eighteen associates, the transfer to the class of members of four associates, and the admission of five students. In the same period the deaths have been recorded of one honorary member, Sir John Herschel, Bart.; of two members, Mr. Newlands and Mr. Suermondt; and of six associates, Captain G. Baillie, Mr. O. Dadian, Mr. T. W. Gardner, Mr. H. de la P. Murphy, Mr. R. Ritchie, and Mr. C. Wilks. There are now on the books fifteen honorary members, 730 members, 1059 associates, and 205 students, making together 2009, as against exactly 1000 on the 30th of November, 1862, so that in less than nine years the gross number has been more than doubled.

McEVOY'S TIME FUSE.

In our reports of field gun experiments at Shoeburyness, with Shrapnel segment shells, &c., we have more than once had to record the miscarriage of a round from the failure of the time fuse. Although much attention has been given to this subject, the ordinary time fuses have not yet reached perfection, but, on the contrary, their use is attended with considerable uncertainty. The burning composition of these fuses is liable to deterioration, and they are open to many other serious objections. These considerations have led Captain C. A. McEvoy, of the London Ordnance Works, Southwark, to invent the time fuses illustrated in the annexed engraving. The novelty in these fuses consists in their being time or distance fuses, without burning composition. Their action being entirely mechanical, it is claimed that they possess important advantages in regard to safety in handling, and certainty of action, over ordinary time fuses.

FIG. 1

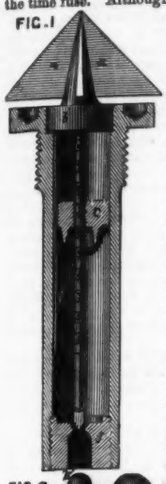


FIG. 2.

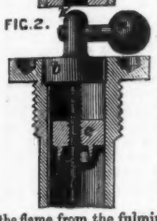


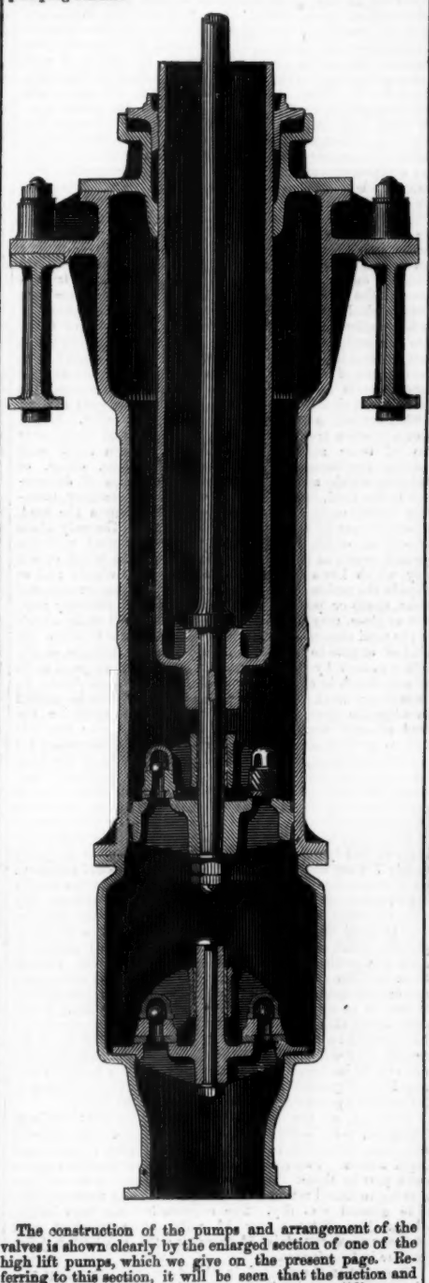
Fig. 1 shows a fuse which acts during the flight of the shell, by means of the resistance of the air on small vanes, *a a*, attached to a spindle, *b*, and causing the latter to rotate longitudinally in the centre of the fuse. The spindle has a scale of figures on its side, and is screwed for about three-fourths of its length. A firing nut, *c*, having points on its lower face, runs on the screw of the spindle, and is prevented from turning with it by a rib, *d*, in the side of the fuse which fits in a slot in the side of the nut. The rotation of the spindle runs the nut off the screw at its lower end, the inertia of the nut causes it to fall with force on a thin layer of fulminate in the upper face of the screw plug, *f*, thus exploding the shell charge by the flame from the fulminate communicating with the small magazine of powder, *h*, in the lower face of the screw plug. The spindle with the nut attached is made to be put into and taken out of the fuse in action, and may be transported separately. To adjust the time of the fuse before firing, the spindle is withdrawn and the firing nut run up or down to the desired figure and again inserted. The speed at which the spindle rotates is partly regulated by the angle at which the vanes are set.

Figure 2 shows a fuse with its firing mechanism, similar to that just described, but acting from another law. The spindle, *b*, being eccentrically weighted by arm, *m*, and ball, *n*, and being loose in the fuse, the arm and ball, by their inertia, serve to keep the spindle in one position, while the shell in its flight spins around it, thus running off the nut and exploding the shell in the manner before described. The calculation for the time or distance of the explosion of this fuse is made from the twist or pitch of rifling in the gun, which gives one or a number of turns to the shell in a given number of feet. Captain McEvoy has based this modification of his fuse upon the circumstance that fuses occasionally become unscrewed from the shell during their flight, owing to the contrary direction given to the projectile by the rifling of the gun. The arrangements are both very ingenious, and we hope to see some experiments made to determine their practical value.

PUMPING ENGINES AT NORWICH.

In November last, we published in this journal (*vide* page 297 of our tenth volume) an account of the system of sewerage works carried out at the city of Norwich from the plans of Mr. Alfred W. Morant, the borough engineer, and we then mentioned that these works included a pumping station at which the sewage from the low-lying districts is raised through a lift of 150 ft. to enable it to be conducted through a conduit to the tract of land where it is used for irrigating purposes. When the works were in progress, tenders were invited for the engines required at this pumping station, and from the twenty-four applications sent in to the Town Council, the plans of Mr. Joseph Clayton, of Preston, were —on the recommendation of Mr. James Simpson—ultimately selected, the result being the construction of the engines which we illustrate this week by our two-page engraving and the illustrations on the present and opposite page.

Referring to these illustrations it will be seen that the pumping machinery designed and erected by Mr. Clayton consists of three beam engines placed side by side in the same engine-house, two of these engines being coupled, while the third works independently—a very convenient arrangement. The engines are of identical dimensions, each having a cylinder 35 in. in diameter, with 6 ft. stroke, and each working two pumps—namely, a high-lift pump for raising the sewage through the 150 ft. lift already mentioned, and a low-lift pump by which the storm waters can be lifted into the river Yare, which adjoins the pumping station. In the case of each engine either or both of the pumps can be worked as required. All the pumps are of the bucket and plunger class, the high-lift pumps having 26 in. barrels, 18 in. plungers, and 4 ft. 9 in. stroke; while in the case of the low-lift pumps the diameters of the barrels and plungers are 40 in. and 28 in. respectively, and the stroke is 5 ft. In each engine the rod of the high-lift pump is attached to cylinder end of the beam, while the low-lift pump is worked from the opposite end, the whole arrangement being clearly shown by our two-page illustration. The low-lift pumps raise the water or sewage from the pump well, and discharge it into the river through the pipes delivering into the flood outlets shown on the right of our engraving; while the high-lift pumps deliver in a 2 ft. main nearly 3000 yards in length, which conducts the sewage to the conduit already referred to, a capacious air vessel being provided, as shown, at the point where the main leaves the pumping station.



The construction of the pumps and arrangement of the valves is shown clearly by the enlarged section of one of the high lift pumps, which we give on the present page. Referring to this section, it will be seen that the suction and bucket valves each consist of a cast-iron ring sliding on a central spindle, and faced with india-rubber, this ring itself forming the seating for a number of ball valves, each covered with india-rubber. The object of these small auxiliary valves is to reduce the shock on the main valve at the end of each stroke, and this purpose they are found to fulfil satisfactorily, even when the engines are working at a speed of 20 revolutions per minute. These valves have now been in use about twelve months, and they are found to answer well.

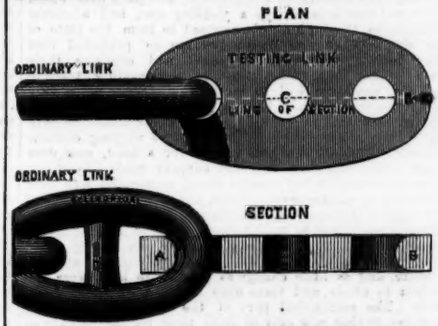
The engines are supplied with steam by four boilers of the Lancashire type, each 27 ft. long by 7 ft. in diameter, with two 2 ft. 9 in. flues. We give on the opposite page a perspective view of one of these boilers, while by the side of it there are shown, detached, one of the flues, and several of the fittings, such as the length of perforated pipe through which the supply of steam is taken off, the scum pipe and its attachments, the feed pipe, dampers, &c. These boilers are very fine pieces of work, and are identical in their general construction with those made by Mr. Clayton for the Houses of Parliament a short time ago. In the outer shell the longitudinal seams are double rivetted, while in the flues the longitudinal seams are welded and the transverse seams are formed in the case of the two joints at the furnace end by flanging the rings outwards, and in the other joints by using rings of T iron, as shown. The fittings are very complete, and include all those recommended by the Manchester Steam Users' Association. The feed is admitted through a check-valve communicating with a perforated pipe, which extends longitudinally within the boiler, about 4 in. above the level of the furnace crowns, the use of this pipe enabling the water to be somewhat warmed before being discharged into the boiler, and also causing the discharge to be distributed. The position of this pipe also does away with the chance of the water being blown out of the boiler in the event of the check valve leaking. The scum cock is fixed on the opposite side of the boiler to the feed cock, and is furnished with a series of collecting troughs, as shown.

The general arrangement of the engines and boiler houses, &c., is shown by the plan on the opposite page, while our two-page engraving explains clearly the arrangement of the pump-wells, foundations, &c. These foundations, we may mention, occasioned works of some difficulty, as the pumping station happens to stand over a depression in the chalk which had to be filled in with concrete, and the water met with occasioned considerable trouble. Altogether the engines at Norwich are very good examples of sewage pumping machinery, and at the present time when so many towns are improving their sewerage arrangements they will be regarded with special interest.

CHAIN-CABLE TESTING AND PROPOSED NEW TESTING LINK *

By R. A. Peacock, C.E., F.G.S., Jersey.

The present writer had the honour to read a paper to the Mechanical Section at Bath, in 1864, "On Chain-cable and Anchor Testing," an abstract of which appears at p. 187 of the report for that year. He there proposed (among other things) the following mode of adjusting the weights of the hydrostatic press:—"Provide a suitably strong coiled steel spring with frame and scale, nearly like a Salter's letter balance, and graduate it up to 5 tons while suspended vertically, by means of actual tons of pig iron placed on the scale, then on laying it down on the platform in connexion with the press, it will become known when the press is exerting a force of 1, 2, 3, &c., tons respectively, and the weights can be adjusted to correspond. Great weights will be multiples of small ones."



It is now proposed to provide new testing links, which it is believed will be found useful in various ways. The following is a description (illustrated by a plan and section along the centre of the testing link) for a cable of which the metal is one inch diameter.

Let the cable manufacturer provide himself with a number of plates of rolled iron, of the same quality as the cylindrical bars of iron, of which the ordinary links are made. The thickness of each plate is to be equal to the diameter of the bar for which it is provided. Eight links will have to be punched out of the plates (by means of a steam punch) of the form shown on the plan; and one new link, when filed half round, as shown near the letters A and B on the section, will be placed longitudinally at each extremity of the cable, with which it will be connected, as shown on the section; and a new link, after being filed as aforesaid, will be inserted longitudinally at every 15 fathoms in each cable, so as to form a part or parts of the cable; and each cable being about 105 fathoms long will require eight new links. The drawing signifies that the metal of each ordinary link of that particular cable is 1 in. in diameter, having the usual "stud" across the centre of the link.

Length of New Link.	in.
Space A	1
Diameter of hole ...	1 1/16
Space	1 3/16
Diameter of centre hole	1 1/4
Space	1 3/16
Diameter of hole ...	1 1/16
Space B	1
Total length of link	8

Breadth of New Link.	in.
Space	1 3/4
Diameter of centre hole	1 1/4
Space	1 3/4
Total breadth of link	4

The use of the centre hole is important. A piece of cylindrical bar iron, say, 6 in. long and a shade less than 1 1/4 in. in diameter, is to be inserted into this hole, and by means of this bar one of the 15 fathom lengths can be connected with the hydrostatic press, the other end of the "length" being fastened at the opposite end of the platform, and then the testing strain may be applied. The remaining lengths can

* Paper read before the British Association.

each be tested in turn by this method. Proverbially "the greater includes the less," that is, if every individual length has withstood the test, *à fortiori*, every individual link has also withstood it; and each of the eight new links may be stamped accordingly, their large flat surfaces affording convenient places for receiving the stamp. And if each new link were stamped on both sides with figures 0, 1, 2, 3, &c., it would at any time be known how much cable had run out of the ship.

1. It might perhaps be supposed that the above-described precautions are all that is necessary, it would appear, however, the fact is otherwise. A cylindrical bar of South Wales iron was tested by the late Mr. Telford, and its increase of length, after the test, was found to be 11.68 per cent., and its diameter was reduced from 1⅞ in. to 1½, it was torn asunder by 43 tons 11 cwt. Another cylindrical bar received 11.87 per cent. increase of length, and its diameter diminished from 1¼ in. to 1. See Barlow "On Strength of Materials," 1837, p. 266 et seq. It would appear, therefore, that if a cable becomes lengthened by testing to an amount exceeding a percentage of its original length, its diameter, and consequently its strength, will have been too much reduced, and it ought to be condemned.

2. Links have been found to be cracked after having apparently withstood the test. It is therefore proposed that each "length," after being tested, should be lifted upon a bench well lighted, and of the height of a table; and then every link should be examined carefully with a magnifying glass, and next the "length" should be turned over, and the other side of it be examined. If any link is found to be cracked, the "length" ought to be rejected.

Ordinary prudence appears to insist that these two precautions ought to be taken.

ON ROAD STEAMERS.*

By R. W. THOMSON.

THE question of traction engines or steam locomotives to work on common roads is a very old one, being of much more ancient date than railways. The attempt to construct a steam engine to run on a common road is probably the most difficult enterprise that mechanical engineering has ever attempted. It is the distinctive character of steam mechanism that it requires to work under almost uniform conditions, as under these alone can the precision of repetition be attained; and it is altogether wanting in the faculty of adapting itself to circumstances. Even in ocean steamers, which at first sight may appear an exception to the rule, the machinery always performs the same definite functions. The path over which the vessel travels is always a yielding one, and whatever vicissitudes the hull may be exposed to from the state of the sea, the engines themselves are so protected that they remain unaffected by these, and continue their own unchanging task. Now in constructing traction engines, engineers had to meet requirements of a very different nature. They had to produce an engine which should work with perfect accuracy and at the same time have the faculty of adapting itself to the most varying circumstances. It would now have to run over a hard, now over a soft road; over wet, dry, and slippery roads. It would have to climb hills and descend them, to pick its way over obstacles, to endure severe shocks, and to take a firm hold of all kinds of surfaces. After trying for a while, the engineers found it so difficult to build a machine to fit such different conditions that they thought they would try if they could not bring the conditions to fit the machine. A uniform surface, and as little change as possible in level were the points to attain, and these were achieved by laying down rails. The mechanical part of the system, namely, the engines, having now only to fulfil their legitimate duty of performing one kind of work with perfect accuracy, became an alluring field for improvements; and so many minds devoted themselves to their elaboration that now, after two generations from the commencement of the scheme, we find that a very high stage indeed of perfection has been reached. But notwithstanding the inappreciable value of railways they still left unfulfilled the want of some means other than animal power of transport in localities where no permanent way could be laid; so once more engineers set themselves to the task of building an engine which should be able to do all manner of things. The problem was scarcely a scientific one, or rather it was not treated in a scientific manner; and those who engaged in it for many years carried on a sort of rude contest between road and engine. When it was found that the rough road broke the machinery, the engine was made so heavy that it destroyed the road. When it was found that the surface of the ground would offer no hold to the wheels, the wheels in revenge, as it were, were provided with claws which gripped the ground, but tore it wofully.

At last Mr. Boydell once more thought of dealing with the question from a scientific point of view—that is to say, he endeavoured to produce a certain uniformity of conditions under which the engine was to work, and to this end provided the wheels with wooden blocks, which laid themselves down in a kind of endless railway. But although theoretically he had been working in the right direction, practically his invention was not a success, as it was impossible to keep the appendages to the wheels from breaking. More years went by, and it then occurred to the inventor of the road steamer to surround the wheels of his engine with a thick tyre of india-rubber. By this means he sought and obtained a very considerable degree of uniformity of condition, because he had, as it were, spread under his wheel a thick carpet of solid india-rubber 4 in. or 5 in. in depth. This to a great extent obliterates the inequalities of the road, and makes it a matter almost of indifference whether the road be hard or soft. Not only does this india-rubber carpet or cushion completely prevent all hard shocks to the machinery—shocks which, passing over paved streets, are quite destructive to ordinary traction engines—but it further saves the road from the grinding action of the iron wheels, which are so terribly injurious to the pathways over which they travel. No regular traffic could be carried on with a common traction engine, weighing 10 or 12 tons, with rigid wheels, without excessive injury to the road, for not only will the hard wheels cut and crush the road, but their destructive action is greatly aggravated by the absolute necessity for having some kinds of projections or teeth to take hold of the road, so as to prevent the wheels from slipping. This has been a very serious objection to the use of these engines, and has raised great opposition to them on the part of road trustees and others concerned in the good condition of the highways. The india-rubber tyres, while they preserve the machinery from all shocks and consequent breakages, likewise preserve the road from all injury; and it is stated by those who have watched the action of regular traffic by means of road steamers that india-rubber tyres actually improve the roads. Mr. John F. White, an extensive miller in Aberdeen, who has been using a road steamer for the last two years, says: "I think there can be no doubt that a road steamer improves a well-made road. I can prove this conclusively. Indeed, I have never heard this doubted in this quarter by any competent authority." Mr. Woolsey, a large brewer in Ireland, who has been working a road steamer for the last ten months, says: "We can produce road contractors and a county surveyor to depone that our road steamer improves the roads." In consequence of the absence of all hard shocks and blows, the engines mounted on india-rubber tyres can travel at a very much higher speed than machines mounted on rigid tyres. For short experimental trips a speed at the rate of from 15 to 20 miles an hour has been accomplished, and continuous journeys at the rate of 10 miles an hour offer no difficulty whatever. The amount of adhesion obtained by the use of india-rubber tyres is very much greater than in the case of rigid wheels. In the latter case, the amount of adhesion is extremely various. On smooth paved streets so little as to be practically valueless. On sandy roads also it is too little to be of any use; and on muddy roads it is even reduced to a very low point. Whenever a traction engine with rigid wheels has to travel over any of these surfaces it is obliged to arm itself with various appliances in the shape of spuds, claws, or paddles, which are all more or less weapons of destruction to the road. India-rubber tyres, on the contrary, maintain a singularly uniform degree of hold upon the road, whatever may be the nature of the surface. The only kinds of soil on which the india-rubber tyres cannot work are ground so soft as to flow away from under the wheel or wet clay, which has a tendency to ball upon the wheels, and so impede the action of the india-rubber. In these exceptional cases, spuds or paddles, such as are used on ordinary traction engines, may likewise be temporarily fixed to the wheels of the road steamer; but it is very undesirable to allow any kind of engine to work upon land in this condition, as the injury caused by the passage of the wheels is so great as to be very much in excess of the value of any work done. In its ordinary work on a farm, which should always be carried on when the ground is dry and in a suitable condition, the road steamer requires none of these appliances: but it is well to provide it with them for any special emergency for agricultural work, as it never requires anything of the kind for road traction work. It may here be mentioned that when the road steamer was first applied to farm work, it came out very clearly that a great deal of the steamer's efficiency would depend upon the proportion of the lightness of the engine to the thickness, breadth, and diameter of the india-rubber tyres. It was found that an engine weighing nearly 7 tons, mounted on tyres 9 in. wide, could not move itself over a damp, heavy clay field; whilst an engine weighing 6½ tons, but mounted on tyres 12 in. wide, was not only able to travel itself with ease over this field, but was also able to haul the engine with narrow tyres and a 3-furrow plough, which was attached to the narrow-tyred engine in such a way that it could not be easily removed. Seeing, then, that the extra breadth of tyre enabled the one engine not only to move itself, but to pull the other engine behind it, and to plough three furrows on this heavy land, it was determined that all steamers built for farm purposes should be mounted on tyres of much greater width than those intended for road work; and the tyres of all the farm steamers are now 18 in. broad, which enables the engine to travel over any kind of ground that is in a sufficiently dry condition to be worked upon without detriment to the soil itself.

Recently, at the Royal Agricultural Show at Wolverhampton, some competitive trials took place between road steamers, with india-rubber tyres, and traction engines with rigid wheels. Two road steamers and three traction engines took part in these. The first trial consisted in the engines having to travel round some rough and very uneven fields. The ground was dry. The engines had no loads behind them. The distance was 1¾ miles. The quickest road steamer went round in 15 minutes; the quickest traction engine in 23 minutes.

The next trial consisted in the same engines going over the same course with loads. On this occasion it had rained continuously for twenty-four hours, and the wet loam was so greasy that it would offer a hold to no kind of wheel. The traction engines all appeared armed with great spikes and paddles, which they so frequently need, but the road steamers were not provided with such appliances. The road steamer Sutherland, which was to compete in this trial, though entered as a farm steamer, lacked the distinctive qualification of Mr. Thomson's farm steamers, its tyres being only 12 in. broad instead of 18 in. Moreover, the engines which Mr. Thomson mounts on these tyres weigh about 7 tons, while the Sutherland's weight was 10 tons 4 cwt. It was decided that the engines should draw lots as to which should go first, and the right of precedence fell to a traction engine with large spuds. It was further ruled that the succeeding engines must follow exactly in the track of their predecessors. The road steamer Sutherland drew No. 2. The traction engine with its big spuds clawed its way round the course, slipping occasionally, and then with its great spikes digging big holes. When it had completed its round, the road steamer Sutherland had to follow in its course, and when it came to the great holes dug by the spudded engine it had very great difficulty, owing to the wet greasy nature of the soil, in getting through them; and, by-and-bye, when the state of things was rendered even worse by a thunderstorm which converted the ground into a swamp, it had to throw off its load, and only with great difficulty, and after several hours succeeded in completing its round. This, as will be seen, was not a trial between rigid wheels and elastic tyres, but was a trial between wheels armed with spuds and paddles and wheels with no spuds. No rigid wheel without such appliances could have travelled 100 yards over this ground; and had it been thought right to use spuds, the road steamer would have derived far more advantage from them than the rigid wheeled engine, and could have gone round with greater ease. But the test was a purely artificial one, for any one witnessing the havoc which these spuds had made with the land would at once perceive that no farmer would ever dream of sending an engine upon his land in that state for any practical work. A very marked illustration of the value of the very broad india-rubber tyres for engines required to work on soft land is the fact, that while the road steamer Sutherland with such great difficulty moved itself over the course, in a neighbouring county, on land in precisely the same condition, and during heavy rain another road steamer, with tyres 18 in. broad, in the presence of a large company, was ploughing, by direct traction, 5¼ acres in 5½ hours.

The third trial consisted in a journey of all the engines from Wolverhampton to Stafford, with loads proportionate to their nominal horse power. The distance was 16 miles, and the road steamer Sutherland beat all the other engines by 45 minutes.

The fourth trial consisted in a rigid wheeled traction engine and a road steamer having to travel over a measured course with maximum loads. The 8 horse power road steamer Sutherland took 36 tons over this course in 10 minutes, and with perfect ease. The 10-horse power rigid-wheeled traction engine took 38 tons over the same course in 50 minutes, with considerable slipping and difficulty, showing that the road steamer would do as much work in 2 hours as the rigid wheeled engine would do in 10 hours. After this a very interesting experiment was made. The 8 horse power road steamer Sutherland, which, with its elastic tyres, had taken 36 tons over the course, had its wheels removed, and rigid wheels substituted, and with these it was found that it could only take 23 tons over the same course, giving a difference of 13 tons in favour of the india-rubber.

The trials at Wolverhampton were all of an experimental nature, and can hardly be looked upon as so conclusive or interesting as some account of what the engines have done in actual work. An engine which, up to August last, had run some 5000 miles, was purchased second hand by the War Office, and set to work partly at Woolwich and partly at the camp, at Aldershot. In reply to some inquiries which the inventor has made concerning the behaviour of this engine, he has received the following information:

Question.	Answer.
Total distance run since engine was first sent to Woolwich, including experimental driving and training of drivers?	Answer. 2800 miles approximately.
Consumption of fuel and water per mile per ton of gross load of train, that is, including engine, wagons, and their loads?	A. 1.86 lb. of fuel, 1½ gals. of water per ton per mile, fuel consisting of 1 lb. of coal to 3 lb. of coke.
Usual running speeds on level roads?	A. With load of 17 tons in excess of weight of engine, 5 miles per hour. With load of 7 tons in excess of weight of engine, 8 miles per hour.
Do any leaks occur, especially at the tops of tubes?	A. No.
Or the neck of the pot?	A. No.
If so, what remedies are applied?	A. None required.
Does any deposit form inside the pot?	A. No.
Does soot form inside the tubes, and do they require to be swept out?	A. Yes; they are swept every week when in constant work.
Do any of the tubes burn out?	A. No.
Have any been removed?	A. No.
How many miles will a set of shoes run with ordinary repair?	A. Not known; but the existing shoes have been in use ever since the engine came to Woolwich; those on the driving wheels are serviceable for a long period yet, but those on the steering wheel are rather thin.

The following extract, from a letter from Mr. Williamson, New York, may also be found worthy of attention:

"I cannot let this mail close without telling you of the great success with my new plough, which we have had since I last wrote. We ploughed last week, and after only a few hours' practice with the new gang plough, we drew it with perfect ease through a grass field, ploughing 8 ft. 2 in. wide, and 12 in. deep. I think it would have brought health back to you could you have seen those seven splendid furrows rolling like seven green waves from the plough, and the steamer never slipping an inch, and not the least distressed, holding the water 'half glass,' and not varying from 120 lb. pressure from one end of the field to the other. Then when arrived at the end of the furrow the fireman hops upon the plough, works the raising gear, and by the time the driver has taken his near wheel out of gear and turned his steering wheel, the seven ploughs are in the air clear of the ground, and the whole thing swings around with the engine as

* Paper read before Section G of the British Association.

simply as a two-wheeled cart. The ploughs are dropped as quickly as need be, the fireman resumes his footplate, and the steamer goes humming across the field as straight as an arrow. The ploughs themselves are made of cast steel, hard tempered, and polished like a razor. They cannot be scratched with a file. They took the prize at the Paris Exhibition of 1867."

Mr. White, of Aberdeen, writing on the 2nd inst., says: "From 19th September, 1870, to 30th July, 1871, my road steamer, with grey rubber tyres, has travelled a distance of 3080 miles, dragging gross weight of 13,800 tons, consuming about 92 tons of coals during 204 days at work between dates above mentioned." During this period the wages amounted to 121*l.*; coals, 70*l.*; packing and small stores, 6*l.* 3*s.* 0*d.*; oil and tallow, 15*l.*

Mr. Woolsey, writing on 25th May last, states "that his road steamer of 8 horse power nominal does the work of 14 horses; that the saving is very great is a matter about which there can be no dispute."

THE CORLISS ENGINE.

*Particularly with reference to its economy of steam, and its extreme regularity of speed, even with great variation of load.**

By ROBERT DOUGLAS, Kirkcaldy.

THE peculiar mechanical construction of the Corliss engine is designed to effect, as nearly as possible, a perfect use of steam while entering, passing through, and leaving the cylinder of an engine.

The sagacity of James Watt looked forward to the attainment of all the objects which are now secured by the use of Corliss valves and gear; but increased piston speed, the use of higher steam pressure, and the introduction of a superior class of workmanship, have contributed to the realisation of results which only require to be known in order to be appreciated.

This engine takes its name from Mr. Corliss, an American engineer, who about twenty-five years ago designed the features of construction embodied in its valves and valve gear, and carried on the manufacture of the engine, at Providence, Rhode Island, to a large extent, and with great success.

It is now eight years since the Corliss engine was introduced into this country; the appreciation of its merits has been rapid, and it has been adopted by many leading millowners and users of steam power in all parts of the United Kingdom. A variety of improvements have been made upon the American type of the engine; these, however, relate more to the method of actuating the valves than to the construction and movements of the valves themselves.

The two main objects proposed to be attained by this engine are, 1, to perform a certain amount of work, with the least possible consumption of steam; and, 2, to perform this work with the utmost regularity, deviating to the smallest possible extent from the pre-determined standard of speed.

To a great extent, the attainment of the latter result flows from the former. The reason why an engine at any time exceeds its speed, is because more steam is admitted to the cylinder, and consumed, than is required to overcome the load at the moment; and when the engine falls below speed, it is because sufficient steam is not admitted to overcome the resistance.

Hence the necessity for an arrangement to cut off the steam from exerting pressure on the piston, by a method at once variable and automatic, while at the same time the steam pressure is not reduced by wire drawing. When a throttle valve is used to "govern" the engine, its office is to contract the inlet passage and wire, draw the steam, reducing its pressure, and seriously impairing its effect.

The Corliss engine has no throttle valve. The cylinder has four valves, two being to admit, and two to exhaust the steam. These act practically in the same way as slide valves, only that instead of being flat, the face of each is a segment of a circle, vibrating on a central spindle or axis, within a bored cylindrical seat. These four valves are all moved independently of each other by rods from a vibrating disc or "wrist plate," so named from the similar action of the human wrist. This wrist plate has a pin fitted into it, which is actuated by an ordinary eccentric and rod.

The mechanism which opens each steam valve is thrown out of gear during every stroke of the engine; when this disconnexion takes place the valve is instantaneously closed by a spring, which is cushioned by a small piston closing on compressed air. The instant at which the steam valves are thrown out of gear, and the steam, thus cut off, depends on the position of the balls of the governor at the moment. Taking the case of an engine such as that represented by the diagram before us, which has a 4 ft. stroke, making 50 revolutions per minute, there is provision to adapt the steam supply to 100 variations of load in each minute. This provision is wholly automatic, is effected without any throttle valve, or separate expansion valve, and is altogether independent of the regulation or control of the engineman.

The exhaust valves, on the other hand, open invariably to their full extent, unaffected by the variations of the steam valves.

The moment the steam ports open the valves are in equilibrium, they are thus extremely easy to work by hand, require very light gearing to actuate them, and consume scarcely any power. The steam ports are as short as it is possible for them to be; the whole area comprised in the steam passages and clearance for piston taken together, only amounting to about 2½ per cent. of the contents of the cylinder. There is great facility of access to the valves for examination and adjustment.

Exception has been taken to the details of the Corliss valve gear, on account of a supposed liability to derangement. The experience of mill-owners and others who have had these engines constantly at work for a series of years, controverts this supposition. With the use of the best materials and accurate workmanship to produce the work, and with intelligent care in its management, it is easy to maintain the Corliss gear in good order.

The large number of these engines now at work in this country, and the increasing demand for them, both for home use and for the colonies, is a sure indication of their practical success.

The indicator diagrams before us are taken from engines working under very different conditions.

The first pair are from the cylinder of a condensing engine 24 in. diameter and 4 ft. stroke. Average boiler pressure, 32¼ lb.; average initial steamer pressure in cylinder 28¼ lb.; cutting off at one-seventh, and expanding through six-sevenths of the stroke; average mean pressure throughout the stroke, 17 lb. per square inch. This engine is driving a rice starch mill, where there is little variation, suddenly at least, in the load.

The pair of diagrams on the second line are from a non-condensing engine, 26 in. cylinder, and 4 ft. stroke; average initial steam pressure in cylinder 35 lb. This engine drives a saw mill at Granton Harbour, and is severely tested by constantly varying strains. The indication to the left was taken when the only machinery driven by the engine was a 24 in. vertical saw frame containing 15 saws, cutting a pine log 20 in. square into boards. It then indicated 18.6 horse power.

The diagram to the right was taken from the same engine when driving the large saw-frame with 30 saws, cutting up a log 2 ft. 9 in. square, also the 24 in. saw-frame, with 15 saws in a 20 in. log; and also a large circular saw, small ditto, and flooring machine, indicating with these 124 horse power.

The one diagram shows the engine cutting off at about one-twentieth of the stroke, and the other at fully five-twentieths; this adjustment being entirely carried out by the automatic action of the valves.

The two diagrams on the lowest line are from a non-condensing cylinder, 33 in. diameter, 4 ft. 6 in. stroke, working by bell-cranks two sets of 16 in. pumps, with other smaller ones, in a pit 400 ft. deep.

The pumping shafts are reduced to one-fourth of the speed of the engine—that is, the engine makes four revolutions for one of the pumping wheel. Taking diagrams from the engine at various points at the revolution of the pumping wheel, the remarkable result is found that in the course of ten seconds it varies between the extremes of exerting eleven, and one hundred and thirty-seven indicated horse power.

It is found in practice with this engine, which is at the Halbeath Colliery, in Fife, that the breaking of a spear rod, or anything suddenly going wrong with a bucket makes no difference in the speed of the engine, and thus may often prevent a breakdown.

A subsidiary advantage of the Corliss cylinder when used in a horizontal engine is, that the long exhaust ports in the lower side of the cylinder effectually drain off any water, and almost or entirely obviate danger of accidents from that cause.

* Paper read before Section G of the British Association.

FOREIGN AND COLONIAL NOTES.

American Railway Amalgamation.—The Pennsylvania Railroad Company now controls absolutely 3318 miles of line, the cost of which was 247,970,632 dols., the earnings for the past year having been 50,634,004 dols. The same company has an indirect control over a large additional extent of line. Its revenues, it will be seen, are almost equal to those of an empire.

The St. Lawrence.—A party of American engineers have been engaged in surveying a portion of the St. Lawrence. They commenced work near the boundary line at or near the Williamsburg canal, and intend surveying down to the Lachine Rapids. The particular object of the survey has not transpired, but it is supposed to have some connexion with the right to a free navigation of the river conceded to the Americans by the Washington treaty.

A Monster Chicago Hotel.—The Pacific Hotel, Chicago, which is in course of erection and is expected to be open next spring, covers an area of nearly an acre and a half. Its dimensions from east to west will be 325 ft., and from north to south 186 ft., while its height will be 104 ft. The cost of the building will be about 800,000 dols. The hotel is built of the Amherst (Ohio) sandstone, and already its great façades present a very striking effect.

Cronstadt.—A scheme for the establishment of a commercial port at Cronstadt is once more on the tapis. Various plans have been brought forward by different projectors, including the cutting of a canal through the shallows between Cronstadt and the mouth of the Neva, and the carrying a railway across the gulf from the northern side.

St. Lawrence and Champlain Canal.—A proposed canal to connect the St. Lawrence at Caughnawaga with Lake Champlain has been attracting a good deal of attention recently. A charter granted to the projectors by the Government of the Dominion of Canada will lapse by June, 1872, if a commencement has not been made with the works. The canal, if executed, will be from 28 to 32 miles in length with only 25 ft. lockage.

The Turkish Navy.—The Sultan of Turkey intends to devote his second son, Mehemet Djemal Eddin Effendi, to the naval profession. The young prince, who has just entered upon his tenth year, receives instruction in navigation, &c., three times per week from the Minister of Marine in a little study specially fitted up for him at the new Admiralty buildings, at Kassim Pasha. Turkey would, no doubt, rejoice in some great admiral.

The Parks of New York.—The public parks of New York city, including squares and places, are twenty-three in number, with an aggregate area of 1007¼ acres. The Central Park has an area of 862 acres, of which 43¼ acres are covered with water. The total cost of the Central Park to January 1, 1871, amounted to 11,168,849 dollars.

A Turkish Mishap.—An awkward accident befel a fine locomotive which arrived recently from England for the Roumelian Railway Company. Through mismanagement in transferring it from the ship to the mahone, it was allowed to fall 20 fathoms deep to the bottom of the Bosphorus, opposite the arsenal, where it now lies.

Canadian Public Works Department.—Mr. Bailarge, C.E., son-in-law of Chief Justice Duval, has been appointed assistant chief engineer of the Canadian Public Works Department, in the room of Mr. Rubidge, superintendent.

Street Railways in New York.—The Third-avenue horse railway in New York is 8 miles long, and the average time occupied in a trip is 80 minutes. The first cars were run October 10, 1855, and the number of passengers carried on that day was 22,000. The company now employs 800 men and 1800 horses, and it has 300 passenger cars running. The depôt is an extensive brick structure, to which another storey is about to be added at a cost of 200,000 dollars. The daily earnings of the line range from 3500 to 5000 dollars.

Growth of Philadelphia.—The influence of city passenger railways upon the growth of Philadelphia has probably never been so fully exemplified as it has been this year. Localities in the north-western part of the city which were recently considered almost inaccessible, are—now that the Master-street and Columbia Avenue branch of the Union Passenger Railway is finished—being covered with dwellings and stores.

Servian Railways.—Negotiations have been proceeding for some time at Belgrade between the Servian Government and Mr. Ralph Earle, on the part of Baron Hirsch, with reference to the construction of a line of railway through Servia and its junction on the Turco-Servian frontier with the projected network of Roumelian railways. Mr. Earle consents that the Ottoman lines shall eventually be brought to the point on the border near Uisch, desired by the Servian regency, provided the latter will grant a concession for the construction of the intended Servian line to the Roumelian Railway Company, which Mr. Earle represents.

Vera Cruz and Mexico Railway.—This line, according to a recent report of the engineers, is completed for a distance of 186 miles, leaving 110 miles still to be opened. The chief obstacle to the completion of the line has been the great Methlac ravine, a natural fissure of formidable dimensions, 900 ft. long and 370 ft. deep. At first it was proposed to cross this ravine by a viaduct, but the line will now run along the cliff of the ravine for some distance, until it reaches a spot where the fissure can be bridged by a comparatively small work.

American Cities.—It appears that there are now 134 cities in the United States with a population of upwards of 10,000 each. Massachusetts has eleven of these cities; Main, four; Connecticut, five; New Hampshire, three; Rhode Island, one; Vermont, one; New York, eighteen, &c. Washington is the twelfth city of the Union. There are 25 American cities numbering over 50,000 inhabitants each.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a fair attendance on 'Change at Middlesbrough. Business was brisk owing to the activity in the shipments. As much as 50*s.* per ton was paid for No. 3, and the other qualities were sold at proportionate prices. There are now 127 blast furnaces in the North of England, and of this number 121 are in blast. All the makers are heavily sold forward, and orders are continually coming to hand.

The Nine Hours' Movement.—Up to the present time there is no indication of the strike coming to an end for several weeks yet. It is now over ten weeks since the men in Newcastle turned out for the nine hours' movement. Unfortunately the masters did not meet them to discuss the question, and attempts by third parties to bring about a compromise signally failed. Within the last few days the masters have offered the men the hours worked on the Clyde. This has been refused, and the men seem as determined as ever they were to remain on strike until they obtain all they asked for at Whitsuntide. It is said that the masters intend importing foreign workmen, but it is generally believed that this will be found to be impracticable. To fill the places of about 10,000 men is no easy task. The engineering trade of Newcastle has been seriously hurt by the strike. There are comparatively few workmen left in the town. A great many good orders which, under ordinary circumstances would have been given to Newcastle firms, have been sent to other parts of the country. When the strike is ended it will be a considerable time before the masters will succeed in obtaining good workmen.

The Wages of the Ironworkers.—In reference to the recent decision of Mr. Hughes, M.P., respecting the wages of the ironworkers of the North of England, it will be remembered that the men, through their secretary, Mr. Kane, raised several objections. A letter in reply has been received from Mr. Hughes. That gentleman says he will be glad to enter into any explanations when he comes down to the north, and, in the meantime, the protest will have his most careful consideration. He adds that he will instruct Mr. Waterhouse, the accountant, to verify the figures of the returns submitted to him on the part of the masters, and also to inquire as to the payment in respect of extras. He concludes his letter as follows: "I am sorry but not surprised at the dissatisfaction which my award has given; but I believe that when I am able to meet the men I shall be able to show them that it is a fair one upon the materials before me. If they would prefer another arbitrator pray let them have no scruple in superseding me, and I believe that Professor Fawcett would be inclined to act if the Board were to ask him to do so. I must have some weeks' rest, and I cannot make any positive appointment at present. When the returns have been verified I will name a time."

LOCKING APPARATUS FOR FACING POINTS.

CONSTRUCTED BY MESSRS. SAXBY AND FARMER, ENGINEERS, LONDON.

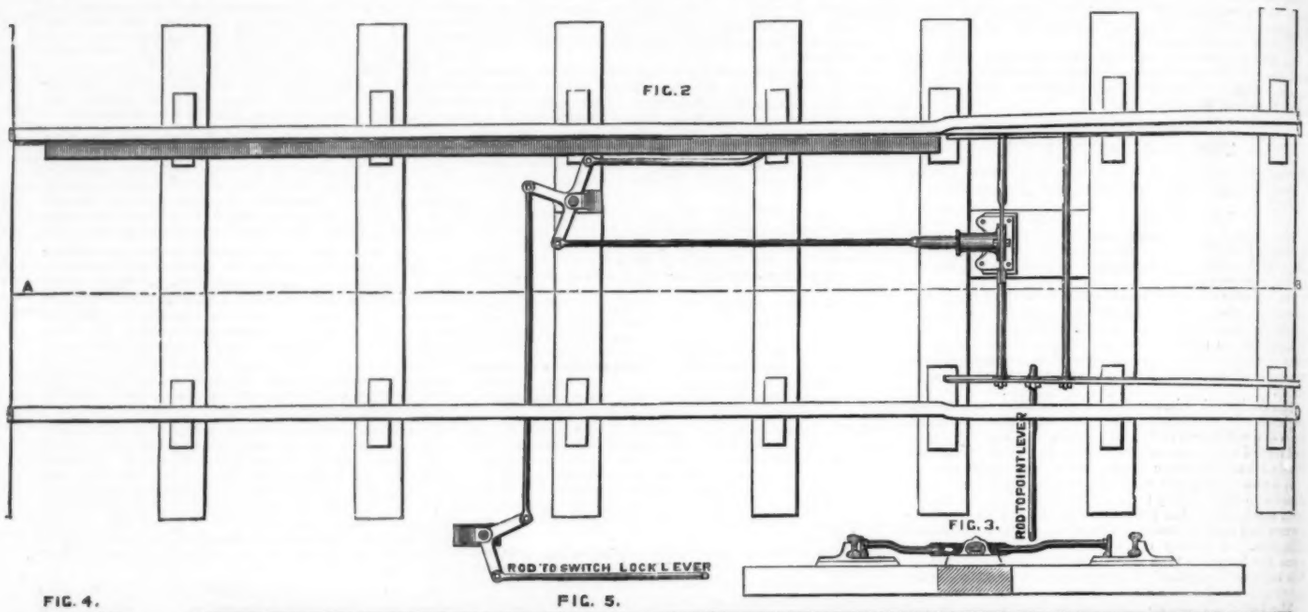


FIG. 4.

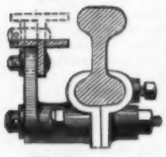
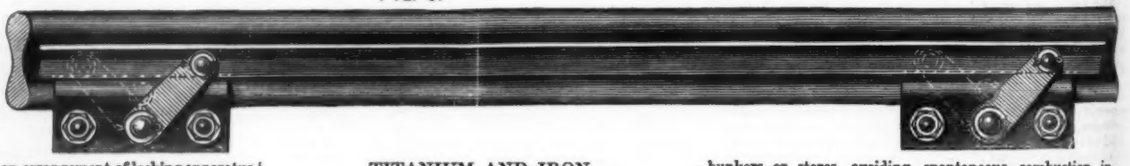


FIG. 5.



We illustrate, above, an arrangement of locking apparatus for facing points, introduced some little time ago by Messrs. Saxby and Farmer, and which, from its simplicity and general effectiveness, cannot be too widely known amongst railway engineers. Referring to Figs. 2 and 3 it will be seen that in this arrangement the movable switch rails are connected near their points by a bar which is flattened near the middle of its length, this flattened portion moving between the cheeks of a casting, which is bolted down to the sleepers. This casting also forms a guide for a kind of plunger, which moves in a direction parallel to the rails, and which is connected by a rod to one arm of a T-lever, as shown in the plan, Fig. 2. The flattened portion of the crossbar, which we have already mentioned as connecting the ends of the movable switch rails, is pierced with two holes so placed that one or the other of them can only be entered by the plunger when the points are fairly home to one or the other of the stock rails. On the other hand the plunger is so coupled, through the T lever and the bell-crank, shown in Fig. 2, to the switch lock lever, that a "clear" signal for a train to pass over the points cannot be given until the plunger has been made to enter one of the holes in the cross-bar already referred to, or, in other words, until the points have been brought fairly home to one or the other of these positions.

This, however, is not the only safeguard, as, by a further provision, it is rendered impossible for a signalman to shift the points either inadvertently or even intentionally while the train is passing over them. This is accomplished by connecting the third arm of the T-lever to a length of T-iron, supported just inside one of the main rails by a series of radius links, as shown in Fig. 1, and by the enlarged views, Figs. 4 and 5. In the positions in which the parts are shown in the figures the plunger is withdrawn from the holes in the cross-bar, and the points are consequently free, but when the plunger is inserted, the length of T-iron is shifted, and the radius links above mentioned are moved into the positions shown by the dotted lines in Fig 5. Now it is evident that they cannot be moved from this position to that shown in full lines without raising the T-iron, and, as during the transit of a train the wheel flanges render it impossible to raise the T-iron, it is rendered equally impossible to withdraw the plunger from the cross-bar, or, in other words, to remove the lock from the points.

Besides the safety afforded by its use, the locking apparatus possesses the further advantage of preventing jolting and jarring by wedging the points firmly in their places, and it is altogether an arrangement which, we trust, in the interest of the public, to see come largely into use.

RAJPOOTANA STATE RAILWAY.—It is stated that the works on a proposed Ulwar line recently sanctioned by the Indian Government in connexion with the Rajpootana State Railway will be commenced during the ensuing cold season.

TITANIUM AND IRON.

TO THE EDITOR OF ENGINEERING.

SIR,—"Hematite" has not given us the information we require, viz., Do the Cumberland and Lancashire red ores contain titanic [acid "abundantly" or not? Mr. Mushet, in his letter said they did. My experience goes to prove they do not. Compounds of titanium are found in the hearths of Cleveland furnaces, but we may select 50 samples of Cleveland ironstone before we can get one with any titanic acid in it, and then the amount is so small as to be only a trace. I can quite realise that a furnace will collect a few pounds of titanium when it smelts 200 tons of ironstone per day for ten or twelve years, the stone occasionally containing a trace of titanic acid. I am rather astonished that none of our Cumberland or Lancashire friends have enlightened us on the subject, but there are many blast furnace managers who smelt ores, the composition of which they know very little about. In the mean time I will endeavour to procure, and thoroughly examine, some of the ore from Big Rig Moor.

I am, Sir, yours truly,

E. T.

Middlesbrough-on-Tees, August 8, 1871.

PEAT FUEL.

TO THE EDITOR OF ENGINEERING.

SIR,—Having been favoured by insertion of my letter in your journal of July 28th last, in response to Mr. Leavitt's able correspondence on "Peat Fuel" in your journal of the 14th July, I beg to request favour of correction of the word "quantity" into "quality," as I intended it to be in my manuscript, and also to be allowed to make a few addenda remarks on peat fuel making and its early introduction on a large scale in Great Britain generally, and the Continent as well, which it is hoped will be recognised and worked without delay. That Ireland, as an island, and as part of Great Britain, is capable of very great improvement and advancement, is admitted by all, but particularly by those who have visited it, and examined for themselves (without prejudice) the immense capabilities and facilities which only await development by means of well-directed capital applied liberally and generously by men of practice and experience in commercial and general undertakings.

In the bog districts particularly, millions of acres of peat lay wasting which could by judicious arrangements and powerful modern machinery, be converted into a splendid fuel, in a condensed form, far superior to the very best coal for steam engines, locomotives, and general purposes, and by the clearance and profitable use of these peat bogs, handsome farms or commercial works could be established for permanent national benefit. It is a well-known fact, that by a proper mode of treatment of the peat, a first-class steam fuel can be obtained of great density and endurance in the furnace, stowing in much less space than coals in the bunkers or stores, avoiding spontaneous combustion in tropics or on shipboard, requiring no raking nor stoking in the furnaces, the peat fuel, by my system, being made ball-shaped or spherical, and by a peculiar mode of treatment by machinery, &c., this fuel will last much longer than coal, will produce steam much quicker than coal, is perfectly clean to handle, and burns brightly, without smoke, smut, or sulphur—immense advantages for steam packets, tunnels on railways, &c.

By extended operations after good selections and proper treatment of thoroughly dried peat by machinery, peat charcoal is obtained, very much superior to wood charcoal for the purposes of iron and steel working, and this peat charcoal, as well as the peat fuel has been tried and proved. That which is required by myself is a fair and liberal aid of those who possess peat bogs, and sufficient capital to practically convert, by my appliances, their waste peat bogs into profit and advantage for themselves, and securing a fair and just remuneration and reward to me for my past twenty years' labour and unceasing perseverance to find out the right and proper means of peat conversion.

Yours respectfully,

W. AUSTIN, C.E.

17, Bristol-terrace, Bermondsey Park, August 7, 1871.

CANADIAN PACIFIC RAILWAY.—Letters from the surveying parties of the Canadian Pacific Railway report that operations are proceeding satisfactorily.

MOSCOW POLYTECHNIC EXHIBITION.—A polytechnic exhibition is announced to take place at Moscow in the spring of next year, and upon an extensive scale. According to the programme, as at present arranged, the proposed exhibition is to consist of two divisions; the one which is intended to occupy the space lying between the river Moskva and the angle of the Kremlin wall near the Taininski Tower will contain the mechanical and manufacturing departments, while the other lying within the walls upon the open square in front of the smaller palace will be reserved for articles of historical interest.

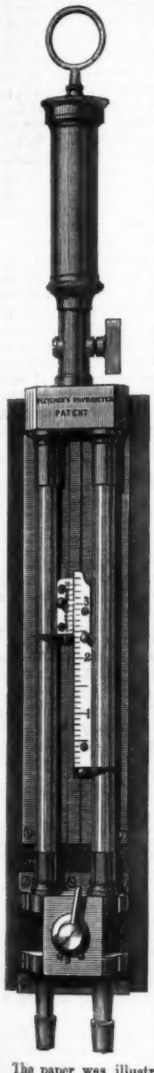
THE DETROIT TUNNEL.—In consequence of the intimate alliance which has been formed between the Great Western of Canada and the Michigan Central Railways the prosecution of a tunnel under the Detroit river seems likely now to become a serious affair. According to the plans proposed, two separate cylindrical brick tunnels, each 8568 ft. long, with an interior diameter of 18 ft. 6 in., are to be constructed 50 ft. apart. The shell of brick masonry is to be 2 ft. thick in the part of the line under the bed of the river and 1 ft. 6 in. on the land portion. The length of the line under the river bed will be 1000 ft., and this portion of the work will be reached by inclines of 1 in 50 passing over 3784 ft. on each side.

THE RHYSIMETER.*

An Instrument for indicating the velocity of Flowing Liquids, and for measuring the speed of Ships through the Water.

By A. E. FLETCHER, F.C.S.

THE principle on which this instrument is constructed resembles that of the anemometer, recently brought into notice by Mr. Fletcher, by which he is able to measure the speed of hot air, flame, and smoke, contaminated with dust or corrosive vapours, as met with in furnace flues and factory chimneys. Both in the anemometer and in the rhysimeter, the impact force of the current, and also its tendency to induce a current parallel with itself, are measured and made to become indicators of the force and velocity of the stream.



The apparatus is very simple. A compound tube with two orifices at the bottom, one of which faces the source of the current, while the other faces the opposite direction, is held in the stream, and communicates by tubes with the indicator where the pressure is measured by columns of ether, water, or mercury, according to the circumstances of the case. When used to measure the velocity of a brook or open stream of water, the speed at any depth or at any portion of its surface can be separately estimated. For taking the speed of water in pipes it is only necessary that there should be suitable cocks screwed into the pipes at the required places, through these the "speed-tube" of the rhysimeter passes without allowing any escape of water, whatever may be the pressure.

A still more important application of the instrument is to measuring the speed of ships. Here the speed-tube pierces the bottom or side of the ship, and projects a few inches into the water outside. The indicator may be in the captain's cabin. It resembles in size and appearance a barometer. In it a column of mercury indicates continually the speed of the ship. The full effect of the velocity is imparted to the mercury, without loss by friction or otherwise, so that the indication must always be absolutely correct. The instrument may be made self-registering, showing by a dial the total number of knots the ship has run since she left port, and marking on a sheet of paper the speed attained at every portion of the time. This permanent register may, in many cases, be of the greatest value.

The rhysimeter is already fixed on board some of the large mail mail steamers running from Liverpool to the United States and Canada, and has proved itself to be of the greatest value. It entirely supersedes the crude process of throwing the log, since it indicates, by simple inspection, the exact speed of the ship at any time and in any weather.

The paper was illustrated by diagrams, and by Tables showing the velocities in knots per hour, or in feet per second, for the various heights of the columns of water or mercury. Several handsome specimens of different forms of the rhysimeter were exhibited.

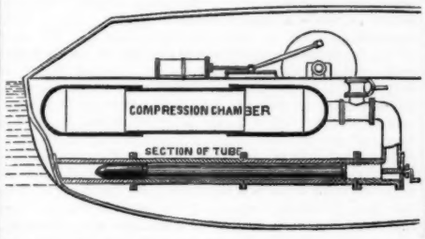
WORKING TORPEDOES.

Description of an Apparatus for Working Torpedoes.†

By PHILIP BRAHAM.

THE exigencies of modern warfare requiring the greatest amount of damage to be done in the shortest amount of time, and naval warfare being the principal defence of England, the question of using torpedoes has long engaged attention. These destructive implements of war are mere bodies of explosive material, either placed in the way or brought in contact with the ship to be destroyed. The mode commonly adopted is to sink these machines to a slight depth below the surface of the water with a fuse at the top, which explodes it when a ship passes over and touches it. Another way is to sink them within view of a camera obscura, and marking the place on the table of that instrument, the wire with which it can be exploded is brought to the observer. A circle is marked on the table, within which the torpedo is effective, and when any aggressive ship comes within that circle, galvanic contact is made with the wire and the explosion is effected; these modes depend on the ship sailing to its own destruction. There is a proposition that at night a boat's crew might destroy a vessel by one of its party swimming to the ship and attaching a vessel of nitro-glycerine by means of pneumatic pressure, and exploding it by electricity. Another proposal is that two vessels should tow one of these machines across the bows of the enemy and then explode it. Another proposition is that the torpedo should be stuck at the end of a bowsprit and run against the enemy.

The method I propose is to propel the torpedo from a ship below its water line by the expansion of compressed air. In the drawing you will perceive the apparatus consists of a chamber into which air can be compressed—a bored cast-iron tube through which the torpedo can be moved—a valve arrangement, by which the progressive velocity of the torpedo is obtained, a sluice valve and breech plate, whereby another torpedo can be introduced when the first is expended. The torpedo itself consists of an explosion chamber at the pointed end, with a percussion fuse, a shaft of wood of any convenient length, and a corrugated cap of sufficient weight to make the whole nearly float horizontally. By means of compression pumps driven from the machinery which propels the ship, I propose to compress air into the compression chamber to 500 lb. to the square inch. When the apparatus is within striking distance of the object attacked, by turning



the lever of a four-way cock the air will find its way under the piston in the small cylinder, which will rise, and with it draw the brass valve opening a port of the shape shown in black. The first opening of this valve will allow but little air to escape (to overcome the vis inertiæ and friction of the torpedo and the column of water in front of it), then the aperture rapidly increasing in area as the valve rises, a steadily progressive velocity will be imparted to the torpedo of sufficient energy to carry it in a straight line far beyond the ship. By the reaction of the force driving the torpedo forward, the ship will have its speed considerably diminished if not entirely neutralised. With sunk torpedoes two boats at night with a rope between them could easily fish them up. The diving suggestion would be impracticable in any but still water. The drawing across the bows would depend upon two ships, which are not easy to control in unison. The running end on might involve you in the destruction intended for the enemy, and would bring you unpleasantly near their fire. In my arrangement it must be allowed that the torpedo will be effective at its own length from the bow, and also at double that distance. The reaction from sending this body forward with an elastic pressure, whose average statical force would be not less than 85 tons on the diameter of 1 ft. 9 in. shown, would certainly act like a buffer, and considerably retard the motion of the ship.

* Abstract of paper read before the British Association.
† Paper read before Section G of the British Association.

LONDON ASSOCIATION OF FOREMEN ENGINEERS AND DRAUGHTSMEN.—At the monthly sitting of Saturday the 5th inst., Mr. Baycott and Mr. Sexton were unanimously elected ordinary members, and a collective visit of inspection to the Crystal Palace was fixed for Saturday, the 26th of August. The authorities of the Palace have promised extraordinary facilities on this occasion, and the families of associates are invited to attend.

THE CENTRAL NATIONAL ART TRAINING SCHOOL.—This school at South Kensington has now closed for the summer vacation. The following are some of the results of the instruction given in the annual report of the Science and Art Department just laid before Parliament. Forty students in training and nineteen national scholars have received allowances of from 10s. to 40s. a week; six students in training have been appointed to masterships of schools of art. As a normal school, the number of the students of all classes who paid fees during the year ending 31st July, 1870, was 565 males and 429 females, total 994. The amount of fees was 262*l.* 14s.; of this sum 44*l.* 12s. was paid by "evening" students only; and the balance, 218*l.* 2s. by day students. The fees have increased over those of the preceding year, 38*l.* 18s. The number of individual students increased from 895 to 994. In this number are included 114 artisans, 14 schoolmasters, and 17 schoolmistresses. The schools were open 205 days during the year, the smallest attendance recorded was 171 on the opening day, the largest, 460 on February 4, 1870. The total number of attendances recorded for the whole year was 60,959, and the average daily attendance 297. The results of the annual examination in 1870 were as follows: Of certificates of the 3rd, or highest grade, 13 were taken, 7 first or elementary being taken by students not then in receipt of allowances. At the national competition, 3 gold medals, 2 silver medals, 6 bronze medals, 6 books or Queen's prizes, and 13 third grade prizes in the elementary stages or local prize section were won by students of the male school. Four silver medals, 4 bronze medals, 6 books or Queen's prizes, and 28 third grade prizes in the elementary stages or local prize section were won by students of the female school. These results have been exceeded during the year just completed, so far as the number under instruction is concerned, while the fees paid have increased from 262*l.* to 282*l.* The schools will reopen on the 2nd of October next, when all new candidates for admission will be required to pass, or to have passed an examination in free hand drawing.

THE BRITISH ASSOCIATION.

FORTY-FIRST MEETING.

EDINBURGH, Wednesday.

THE business of the forty-first annual meeting of the British Association for the Advancement of Science is now at an end, so far as the meetings of the Sections and the reading and discussion of papers are concerned.

Rarely, if ever, has the British Association President been more efficiently supported during the daily sittings than has Sir William Thomson been by his brother physicists this year, and unlike many of his predecessors in office, the President has not confined his labours to the preparation and delivery of the inaugural address, and presiding at the evening lectures and committee meetings; he has, in addition, taken part in the proceedings of several of the Sections, both by means of communications and otherwise.

On Thursday the 3rd inst., the work of the Sections began in earnest. In Section G, mechanical science, the work on the programme was overtaken soon after one o'clock. The opening address of Professor Jenkin gave a great deal of satisfaction, especially that portion of it which treated of the educational wants of persons destined for the engineering professions. It was characterised as one of the most admirable addresses ever delivered to the Mechanical Section. Following that address there were papers on, "A proposed Automatic Gauge for the Discharge over Waste Weirs," by Mr. Thomas Stevenson, C.E., F.R.S.E.; "A New Form of Salmon Ladder for Reservoirs of Varying Level," by Mr. Alexander Leslie, C.E.; "On Designing Painted Roofs," by Mr. Thomas Gillott; "On Chain Cable Testing, and a New Form of Link," by Mr. R. A. Peacock; and "On a New System of Warming and Ventilation," by Mr. J. D. Morrison.

On Thursday evening, Professor Abel, of the Chemical Department, Woolwich Arsenal, gave his lecture on explosive agents in the music hall, to a crowded audience. The lecture was fully illustrated by experiments, diagrams, apparatus, &c., and was a very full and interesting *résumé* of the recent knowledge regarding all known explosive materials, both new and old. The only fault of the lecture was that it was too long for such persons as only affect science. It lasted for nearly two and a half hours. On the following day there were papers on, "An Instrument for Measuring Speed of Ships or Flowing Water," "Road Steamers," "The Gauge of Railways," and "The Corliss Engine," the authors being, respectively, Messrs. A. E. Fletcher, R. W. Thomson, Robert F. Fairlie, and Robert Douglas.

Friday evening was devoted to a crowded reception given by the Principal and Professors of the University in the hall of the University library.

There was on Saturday a *dies non* both in the Mechanical and Chemical Sections. A number of the habitués of Section G betook themselves to Leith in order to inspect one of Thomson's road steamers at work, and to inspect Carr's wheat disintegrator at the Bonnington Steam Flour Mills. About a hundred persons engaged in mechanical and chemical pursuits had an excursion by special train to the great works of Young's Paraffine Light and Mineral Oil Company at Addiewell, West Calder, on the invitation of Mr. Young and the directors of the company, Dr. Lyon Playfair, M.P., and others of whom were present on the ground to accompany the visitors through the various departments of the works.

Monday's papers in the Mechanical Section included a report of the Rainfall Committee, by Mr. G. J. Symons, together with papers on "A New Form of Steam Blast," by Mr. C. W. Siemens; "A Thermometer of Translation," by Mr. Thomas Stevenson; "A New Mill for Disintegrating Wheat," by Mr. Thomas Carr; "Improved Ships of War," by Mr. Michael Scott; and "An Apparatus for Working Torpedoes," by Mr. Philip Braham. On the evening of Monday Mr. E. B. Taylor delivered his lecture in the music hall on primitive civilisation, but the audience was not so large as at Mr. Abel's lecture.

The communications read yesterday (Tuesday) in the Mechanical Section were "Report of Committee on Treatment and Utilisation of Sewage," a paper "On the Carbon Closet System," by Mr. E. C. C. Stanford; "Interim Report of Committee on Steam Boiler Legislation; and a paper "On Steam Boiler Legislation," by Mr. L. E. Fletcher. And to-day, although most of the sections did not meet, Section G was called together for two papers, one of which was on "The Rainfall of Scotland," by Mr. A. Buchan, F.R.S.E., secretary of the Scottish Meteorological Society. The other, by Mr. Thomas Stevenson, was not read.

At the meeting of the General Committee on Monday afternoon the president for the Brighton meeting in 1872 was chosen, Dr. W. B. Carpenter, the eminent physiologist and naturalist, being elected to that honourable post. The vice-presidents and other officers were also elected on the same occasion, and the 14th of August was fixed as the date of the opening meeting. There were afterwards considered the applications for the 1873 meeting. Bradford put in its third formal application, Belfast its second, and Glasgow its first. In each case the applications were supported by large and influential deputations, and the claims of the respective towns laid forth. Bradford was moved by Admiral Sir Edward Belcher, and seconded by Mr. Mayall, and as no other proposal was made either on be-

half of Belfast or Glasgow, the great woollen town of the West Riding of Yorkshire was fixed upon for the meeting in the year 1873. The president for that meeting will be elected at Brighton next year.

NOTES FROM THE SOUTH-WEST.

Pontymoile Tin Works.—These works have passed into the hands of Messrs. J. Richards and Co. Working operations are about to be commenced, much to the satisfaction of the inhabitants of Pontypool.

State of Trade at Merthyr.—The iron trade still continues brisk in the district about Merthyr. The difficulties in the steam coal trade are expected to be overcome by an importation of labour from Staffordshire, Cornwall, &c., at any rate, efforts are being made in this direction.

Bath Water Supply.—An official report of the water supply committee of the Bath town council states that the committee has accepted the tenders of Mr. T. Spittle, of the Cambrian Iron Foundry, Newport, for the supply of pipes to be laid in the parish of Bathwick, and the tender of Mr. W. Mitchell, of Bath, for opening and filling in ground, and laying pipes in the same parish. The committee has arranged with Mr. G. Taylor for entering upon his land for laying pipes in the Oakford Valley; the works there are now nearly completed. A further sum of 6500*l.* has been paid to Messrs. Cochrane, Grove, and Co., on account of their contract for iron pipes, and the sum of 1750*l.*, has been paid to Messrs. G. Price and Co., on account of their contract for laying pipes, &c. A total of 33,500*l.* has been raised by mortgage of the water rates, &c., and at an interest of 4 per cent. per annum.

Clifton Extension Railway.—A contract for the construction of a line from the Midland Railway to Clifton and the docks at Avonmouth has been let to Messrs. Lawrence. The works are to be commenced immediately. The line is to be a double one throughout.

Bristol and South Wales Railway Wagon Company (Limited).—The 21st half-yearly meeting of this company was held on Wednesday. The revenue account showed a disposable balance of 8284*l.*, after carrying 1256*l.* to the depreciation fund, being at the rate of 5 per cent. per annum on the cost of the wagons for hire. The rolling stock now belonging to the company consists of 6683 wagons and carriages, being an increase during the half-year of 89, after deducting 569 wagons sold and redeemed.

Trade at Newport.—At the last South Wales and West of England coal and metal market, at Newport, the attendance was rather thin, but the reports received as to the state of the iron and tin plate trades were satisfactory. Rail makers are fully employed at good prices, and merchant bar makers are indisposed to take orders unless at advanced rates. Hematite pig and ore are quoted at very high prices.

Bristol Docks.—The docks committee of the Bristol town council has reported that there has been no falling off in the trade of the port this year, the receipts for tonnage having been 24,220*l.*, in 1870-1, against 24,211*l.*, in 1869-70; and for goods, 13,203*l.*, against 13,215*l.* The total expenditure for the past year amounted to 101,558*l.*, including 60,828*l.* spent on river and harbour improvements, and 9107*l.* on the railway wharf depôt. The engineer reports that the upper lock leading from Cumberland Basin into the Floating Harbour has been nearly completed, and will be opened in about a month. The other lock is also in an advanced state. The quay walls above and below Prince-street Bridge are completed. Rails are being laid down on the lower, and this part will be connected with the harbour railway by the end of August.

Welsh Shipping Movements.—The Propontis, screw steamer, has cleared from Constantinople and Smyrna with 571 tons of bar iron supplied by Mr. R. Crawshay. The Griuneug has cleared from Newport for New York with 689 tons of iron supplied by the Ebbw Vale Company. The Celeste Clarke has cleared from Cardiff for Boston with 1000 tons of railway iron supplied by the Aberdare Iron Company. The Charlton, screw steamer, has cleared from Cardiff for Rotterdam with 1050 tons of railway iron supplied by the Aberdare Iron Company. The Edina has cleared from Cardiff for St. John's, New Brunswick, with 800 tons of railway iron supplied by Messrs. Guest and Co. The Austin Friars has cleared from Cardiff for Montreal with 1560 tons of railway iron supplied by the Aberdare Iron Company. The Teresina has cleared from Newport for Montserrat with 343 tons of iron supplied by the Ebbw Vale Iron Company. The Kalstadi has cleared from Newport for Montreal with 730 tons of railway iron supplied by the Blaina Iron Company. The G. W. Halls has cleared from Cardiff for Halifax, Nova Scotia, with 650 tons of railway iron supplied by the Rhymney Iron Company. The Principe di Napolo has cleared from Cardiff for New York with 480 tons of bar iron supplied by the Rhymney Iron Company. The Light of the Age has cleared from Newport for Ylo with 680 tons of iron supplied by the Ebbw Vale Company.

Welsh Companies.—The Ebbw Vale Steel, Iron, and Coal Company (Limited) contem plate building two new furnaces at the Race Works, besides repairing those now standing idle. When all are completed there will be six in full blast instead of the two now going. The Ynisedayn Iron, Coal, and Steel Company has just succeeded in winning a valuable vein of coal.

The Port of Cardiff.—The quantity of coal exported to foreign ports from Cardiff in July, was 89,005 tons, and of coke 89 tons. In the total of 89,005 tons, the following places figured for more than 3500 tons each: Barcelona, 8039 tons, Bombay, 4440 tons, Callao, 3565 tons, Havre, 3438 tons, Port Said, 3446 tons, St. Jago de Cuba, 3494 tons, St. Nazaire, 9611 tons. The quantity of patent fuel exported from Cardiff, in July, to foreign ports, was 6995 tons. The quantity of coal exported coastwise from Cardiff, in July, was 61,156 tons, and of patent fuel 700 tons. The quantity of iron exported from Cardiff, in July, was 21,428 tons. In this total the following ports figured for upwards of 1500 tons each: Montreal, 2460 tons, New Orleans, 1506 tons, New York, 7029 tons, and Quebec, 1556 tons. In spite of the strike the shipments of coal from Cardiff have been slightly increasing of late.

South Wales and West of England Coal and Metal Markets.—A market was held on Saturday at Swansea. Some important sales of Spanish ore were negotiated, and hematite pig was in great demand. The makers of this class of iron are so heavily sold that they will only quote at a considerable advance on old prices. There have been large discoveries of ore in the Furness district, but the supply hardly keeps pace with the demand. Oxfordshire iron ore is being introduced at the principal iron works about Swansea.

Trade at Cardiff.—A considerable amount of activity prevails at the iron works in the Cardiff district. Scarcely any Russian contracts have been secured by the Merthyr and Aberdare iron masters, but there are large American and Canadian orders on the books. The traffic of the Taff Vale Railway continues to be reduced by the colliers' strike, but it appears to be reviving.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The warrant market is still showing signs of improvement. A large business was done in warrants last week. This day week a fair business was done up to 61s. cash and 61s. 3d. one month; on the following day the market was rather irregular, and on Friday prices rather gave way a little, but improved towards the close of the market, 61s. 4d. one month sellers, with buyers 61s. seven days. On Monday the market opened strong, 61s. 1½d. cash, and 61s. 6d. one month being given in the early part of the day; a rise of 2d. to 3d. was given yesterday, and to-day there has been a slight downward reaction.

The Edinburgh Street Tramways—Commencement of the Work.—The inhabitants of the west end of Edinburgh were very much surprised to find their thoroughfares in the possession of the navvies on Monday morning for the purpose of commencing the street tramways, the contract for which was only let last week. The contractor for the first portion, that which extends from the Haymarket in Edinburgh to Bernard-street, Leith, with a loop line by St. Andrew-square and York-place, is Mr. Gowans, a gentleman of great experience in railway works. Operations are to be commenced at both ends, and in half a dozen other places. The rails, which are supplied by Whitewell and Co., Middlesbrough, are laid down, and also the granite blocks, which are furnished by Shearer, Smith, and Co., Dalbeattie. The material used for the work is brand new, picks, spades, wheel-barrows, and all. There is every prospect that the work will be completed within the time specified (November 30). The contract provides for a penalty of 200*l.* for every week after the 30th that the work may be incomplete, and a premium of 200*l.* for every week it is finished before the time. Mr. Gowans appears to be going in for the premium.

Statue of the Late Master of the Mint.—Mr. Brodie, R.S.A., Edinburgh, has just completed the model of a colossal statue of the late Professor Graham, Master of the Mint. The statue is to be cast in bronze and erected in the south-east of Georges-square, Glasgow, balancing the statue of James Watt in the south-west corner of the same square, the whole expense being defrayed by Mr. James Young who in early life was his student and assistant, and in after life his intimate personal friend. The figure is colossal, in a sitting posture; in an erect position it would stand about 10 ft. high. The professor is seated in an arm-chair, with his D.C.L. robe enveloping his figure, and a volume in his hand with symbolical effigies of philosophical instruments on the cover. The massive and thoughful features are finely modelled, and the likeness is very happy.

Proposed New Lighthouse in the Shetlands.—The Pharos steamer arrived at Lerwick on Thursday, the 3rd inst., with the Commissioners of the Northern Lights on board on their annual tour of inspection. It is expected that a new lighthouse will soon be erected on the Ve Skerries on the west side of the Pentland Isles.

The Iron Dredger and Hopper Barge Trades on the Clyde.—A large new iron dredger, built and engined by Messrs. W. Simons and Co., was on Saturday launched from the London Works, Renfrew. It is the property of the River Tees Conservancy, Stockton, and has been constructed to the order of Mr. Fowler, their engineer; it is 140 ft. long over all, 25 ft. broad, and 20 ft. high; is designed with double bucket girders, so as to have the properties of two dredgers in one hull. It is fitted with every improvement introduced by the builders, and all its movements, whether hoisting, lowering, dredging, going ahead, astern, or sideways, are executed or controlled by steam power; and its massive proportions may be judged by the fact that in its construction are over 10,000 pieces of iron, brass, and steel, each different from the other. With such a tool it is evident no British engineer need hesitate either to cut a ship route at Darien or Ceylon, or remove any obstructions at present impeding navigation. On the same day Messrs. Thomas Wingate and Co. launched two iron screw-steam hopper barges, each of 252 tons B. M., and 30 horse power nominal. These barges are of novel construction, being specially adapted for discharging their load in shoal water. They will be employed, in conjunction with a powerful steam dredger, recently launched by the same firm, in carrying out the extensive improvements of the navigation of the Rio Sao Goncalo, Brazil, under the superintendence of Messrs. Storry and Smith, C.E., Glasgow. They are named respectively Portador and Coadjutor. Messrs. Wingate and Co. have just completed, and are shipping in pieces, two small dredgers for the Government of Equador.

INDIAN DIRECT APPOINTMENTS.

IT will be with no small astonishment that the following particulars are read of the recent examination for direct appointments to the Indian Public Works Department. As this examination had been publicly advertised as the last of its kind, it might have been expected that an unusually large number of candidates would have come forward. Such, however, does not appear to have been the case. The smallness of the number of candidates may, however, partly be accounted for by the fact that all under twenty years of age were this year excluded, no doubt with the view of preventing as much as possible any chance of drawing candidates away from the college. Altogether we learn that 51 candidates were accepted in the first instance, of whom one retired before the commencement of the examination. Of the remaining 50, no less than 17 were rejected by the Medical Board, leaving only 33 to enter into competition for the 20 appointments that were offered. Out of these, however, only four were ultimately found qualified for the public service. This result is certainly, at first somewhat startling, but a little consideration will, we think, clearly explain the true cause of the small number of successful candidates. With regard to the large number rejected by the Medical Board, it only tends to prove that those candidates who were rejected had not taken the ordinary precaution beforehand of ascertaining, as they might easily have done, whether or not they had any physical affection which would be likely to render them unfit for service in India. Of course, all sorts of explanations are given by the candidates themselves to account for the small number who passed, but in our opinion the cause of failure is chiefly to be found in the fact that this year an entirely new set of examiners were appointed, and consequently the papers given by them contain a greater variety from those of former years than might otherwise have been the case; and as the system of preparation for these examinations has generally consisted of mere cramming, any change in their character was certain to be attended with results similar to what we have now witnessed. The examiners on the present occasion were Professor William Pole, F.R.S., M.I.C.E., Examiner in Engineering, the Rev. Joseph Wolstenholm, M.A. (Professor at Coopers Hill College), Examiner in Mathematics, and Captain W. H. Edgcome, R.E., A.I.C.E. (Professor at Coopers Hill College), Examiner in Surveying. The papers given at this examination were, in our opinion, an improvement upon those of former years, especially the one in engineering. This last comprises a small book. It is divided into two parts, the first part relating to "Applications of the Sciences to Engineering," including Statics, Dynamics, Hydrostatics, and Hydraulics, Heat, Fuel, Steam, &c., Metallurgy, Geology, Mineralogy, &c., and the second part relating to "Practical Construction," which included the following subjects, viz.: general construction, construction in iron, railways, steam engine and machinery, waterworks, and miscellaneous questions; the whole concluding with an examination in measuring and computing quantities, and in estimating.

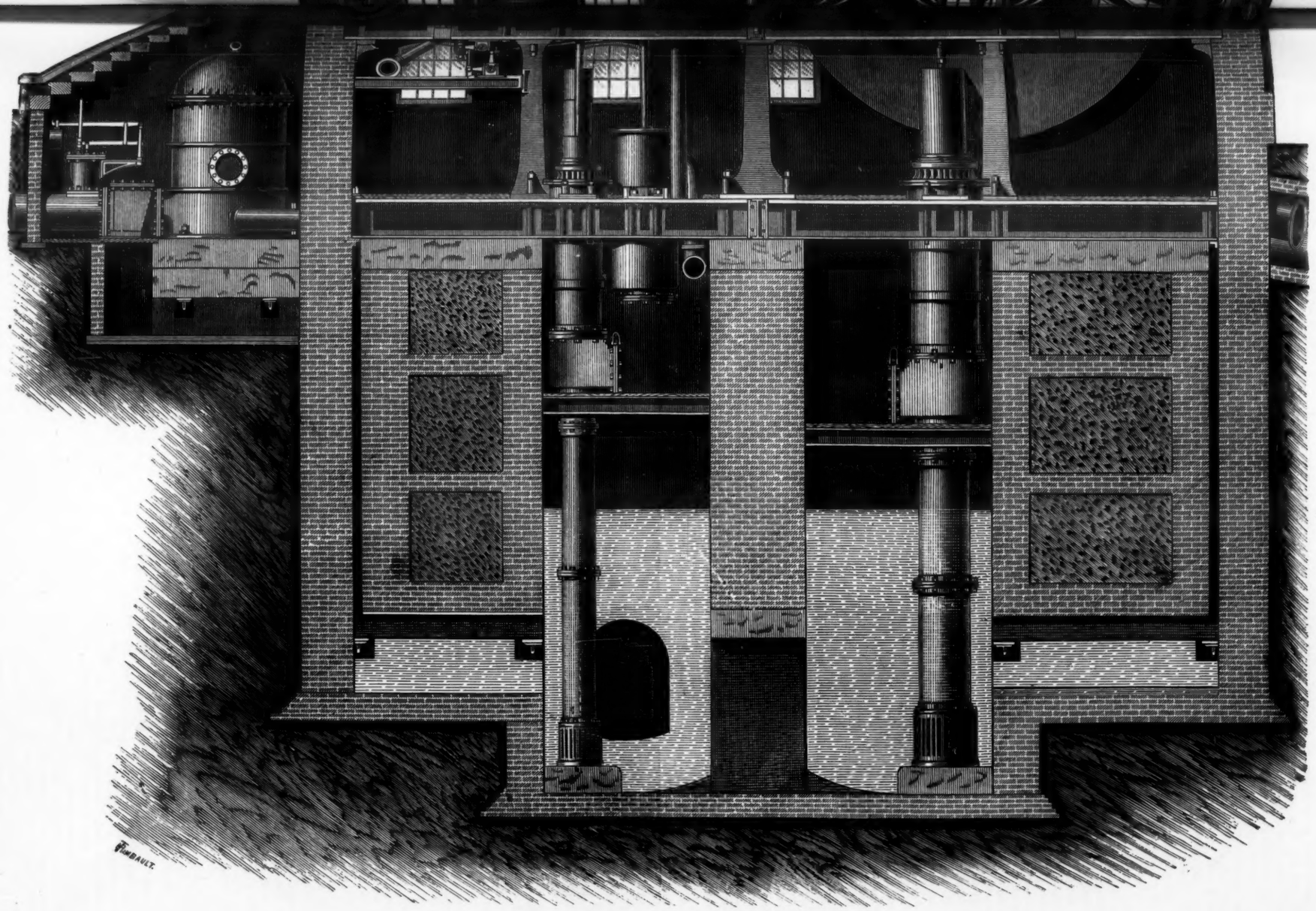
The names of the successful candidates are given below, together with particulars of their education, and the number of marks obtained by them in each subject. The total number of marks that could be obtained in the various subjects were, Mathematics, 400; Engineering, 280; Estimates and Specifications, 80; and Surveying, 240, making together a total of 1000 marks. The minimum number of marks for successful candidates was fixed at 600, of which not less than 200 must be for Mathematics, not less than 180 for Engineering, and not less than 100 for Surveying.

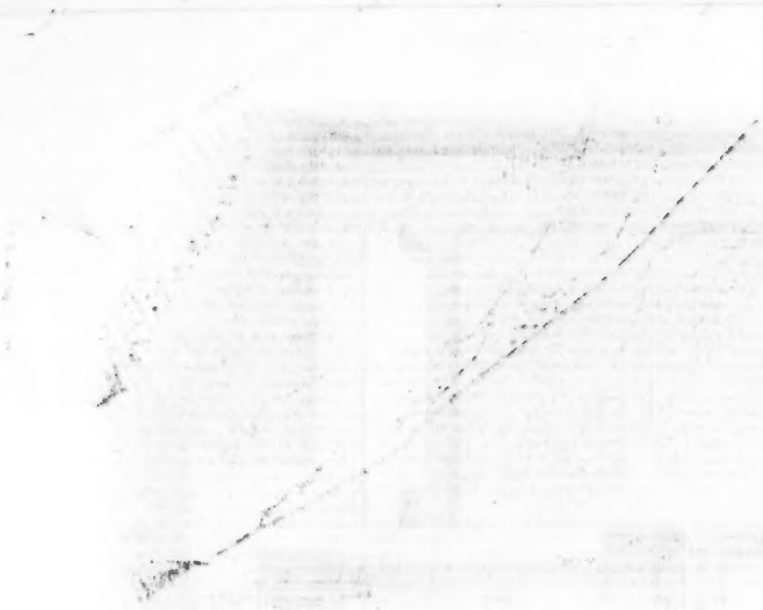
NAME.	Number of Marks.				Age.	Place of Education.	Engineer under whom served.
	Mathematics.	Civil engineering.	Surveying	Total.			
1. R. McH. Mellias ...	273	275	106	654	21	Glasgow University ...	G. Martin, C.E., Glasgow R. Dunlop, C.E., Glasgow
2. E. Gibson	200	266	147	613	20	Queen's College, Belfast ...	Dundalk and Greenore Railway
3. A. G. Reid	208	293	107	608	20	King's College, London ...	G. F. Armstrong, C.E., London
4. L. F. Maclean	267	225	114	606	23	Glasgow University ...	J. P. Smith, C.E., Glasgow Dingwall & Skye Railway

PUMPING ENGINES AT THE NORWICH SEWERAGE WORKS.

CONSTRUCTED BY MR. JOSEPH CLAYTON, ENGINEER, PRESTON.

(*For Description, see Page* 85.)





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CONTENTS.

	PAGE
Bauschinger's Indicator Experiments on Locomotives	83
Norwich Sewerage Works: Boilers and Plan of Pumping Station	84
McEvoy's Time Fuse	85
Pumping Engine at Norwich	85
Chain Cable Testing, and Proposed New Testing Link	85
On Road Steamers	86
The Corliss Engine	87
Notes from Cleveland and the Northern Counties	87
Foreign and Colonial Notes	87
Switch Locking Apparatus	88
Peat Fuel	88
Titanium and Iron	88
The Rhysimeter	89
Working Torpedoes	89
The British Association	89
Notes from the South-West	90
Notes from the North	90
Indian Direct Appointments	90
Admiralty Incompetence	91
Our Coal Supply	91
Opening of Coopers Hill College	93
Institution of Civil Engineers	94
Notes from Paris	94
Disintegrating Grain	95
The British Association	95

ENGINEERING.

FRIDAY, AUGUST 11, 1871.

ADMIRALTY INCOMPETENCE.

THE Parliamentary Session will conclude, and the members of both Houses, and the chiefs of various departments, will scatter themselves for the next few months, leaving behind them well-grounded dissatisfaction that will develop into a determination for reform when Parliament shall next assemble. And this dissatisfaction is not partial but general; it points to no individual shortcomings, but to general incompetency; to a Government that has promised so much and has done so little; to a Home Office that vacillates between illegal opposition and weak yielding to the mob; to a War Office that has hidden its incompetency for so long under big talk and bold assertion, but fails utterly under the first small practical test; to an Admiralty, still more incompetent, still more prone to conceal weakness beneath large words, and the heads of which when called to give an account of their stewardship, have no course left but to break down physically when a Captain has been lost, or to throw themselves on the mercy of the public when a Megæra has been wrecked. The nation is long-suffering and full of patience: it will pay and pay unceasingly and almost uncomplainingly; it is anxious and able to have the finest navy in the world, as it has the finest sailors, as it has the finest constructive ability; but when it sees ships lost in succession, lives wasted or criminally risked, and when it sees that all this arises from nothing but sheer incapacity, the time is close at hand for a full reckoning with the leaders in whom it placed such ill-used confidence, and for such sweeping reforms as shall effect a change, and shall remove heads of departments from responsibilities they trifle with by the indulgence of private pique, or for which—possessing full integrity, and desire to promote the public good—they are quite unsuited. The Captain, Megæra, and the Agincourt disasters, and the expulsion of Mr. Reed from office, are the striking features that have distinguished the Admiralty under the present administration. We have already said all we need say about the first-named for the present, for, although an earnest movement is now being made to reopen the subject, it is not likely to be successful, and the matter will probably stand over till Mr. Childers is pronounced fit to answer the allegations brought against him, or until it is shelved altogether. With regard to the Agincourt, the policy of economy so much vaunted, but now rapidly leading up to excessive necessary expenditure, has its share in this disaster. The desire to save coal endangered, and might have lost the ship, whilst in the case of the Megæra, there is not one extenuating circumstance, one single thing that can be urged in defence of Mr. Goschen, except, indeed, his total ignorance of the matter with which he had to deal, a poor excuse, which augments rather than reduces his responsibility. Consider the circumstances of the case. We have a ship built twenty-two years ago, comparatively imperfect in her design and her construction even at first; condemned since five years for all except temporary service; a ship whose character was so well known that for years she had been placed last on the list of many other unreliable vessels. She was not employed even as a store ship during the Abyssinian war. In 1866 she had been certified as fit, when repaired, only for two years' further temporary service; and when latterly Mr. Barnaby reported upon her, the utmost he could say in her favour was that her boilers were good only for one year's service. In the face of all these facts the Megæra, with her invaluable freight, is ordered to the other side of the world for at least nine months' active service, or only three less than the sanguine assistant constructor had been able to give as the limit of duration of her vital parts. We all remember the events that attended her departure, the inconveniences, the dangers, the remonstrances; we remember the paltry inspections and altercations the question raised in Parliament, and the loud mouthed denial with which the Admiralty attempted to hide their folly.

Results have shown how just were the doubts, and how inexcusable was the action taken in the matter at the time. Fortunately the Megæra has not achieved her journey in safety, or the Admiralty emboldened by their good fortune, would have ventured on other economical extravagances, and have secured themselves still more strongly in their position, which the Captain disaster, and the subsequent events had seriously shaken. As it is we have lost a ship that was fit for little more than the breaker's yard, we have lost stores, the temporary service of nearly 400 men, and the cost that will be incurred in rescuing the crew by the ship sent to their aid. We have lost all these things, thanks to the policy of a department that did not scruple to send out a crazy ship, despite all the documentary evidence before it, for the sake of saving a trifling sum by the transaction. But, as we have said, the loss is fortunate—so that the crew is safe—for the sinking of that old iron ship must drag down some incompetency with it to make way, we hope, for a better state of things.

It has been urged, on behalf of the First Lord, who, we believe, is one of the most sincere and conscientious of men, but whose talents are at present so misplaced, that he is free from blame because he did no know the exact condition of the ship. No assertion could be more fallacious than this. In accepting supreme power he accepted supreme responsibility; and even had the means for attaining the required information not been available, except from direct inspection, such as had been made in 1866, and which could not have been repeated by Mr. Barnaby, his liability would not have been reduced. He stands, then, compelled to answer to the country for the blunder he has committed, a victim probably to a system by which offices requiring great special knowledge and natural suitability, are held by comparatively short, and always uncertain tenure, and certainly a victim to a Government which hastened to fill the gap left vacant by Mr. Childers, apparently careless of the eligibility of his successor.

Public opinion has been asked to suspend its judgment until the exact details of the Megæra disaster are known, a request as politic as it is unreasonable; one which, if complied with, would result in the postponing of the question for months, until Parliament reassembled, and the press of other business should entirely dispel the further consideration of the event. The fact is that the culpability of the Admiralty will not in one degree be lessened if it shall be found that the apprehended cause is not the true one. For the faults of the existing system stand confessed, and it is for these faults that the Department is now being judged. A vessel long known as unfit for the service, is sent upon an Australian voyage; she is lost, and the head of the Department is obliged to own ignorance of information which lay ready to his hand, a lapse of duty for which a subordinate clerk in any private employment would have been ignominiously dismissed.

In the midst of the discussion consequent upon the Megæra catastrophe, we, of course, see Mr. Reed active in the journals, and Mr. Reed's friends active in the House, smiting his old enemies of the Admiralty. More and more strongly do circumstances help Mr. Reed; he prognosticates, and his words, more or less, come to pass; he has been uncomfortably prophetic about the Glatton and the Minotaur, but his remarks have the air of being convenient prophecies, useful to be kept on hand, and brought forward in case the elements and official blundering should interpose still more in his behalf. They are unfortunate, those differences between the Admiralty and Mr. Reed. How ungenerously, how unfairly, as he himself says how insolently he was treated, let the published correspondence tell. But public sympathy has always a leaning towards the more powerful party, towards the employer rather than the employed; Mr. Childers must have had strong reasons for his conduct, it would have been too glaring otherwise, and was it not endorsed by the highest authority in the House? So, despite the knowledge that Mr. Reed not only did all of importance that has been done to our fighting fleet, but also that he preserved the Admiralty credit during his tenure of office, and notwithstanding that no one can by any possibility lay the finger of censure on any spot, a general impression reigns that Mr. Reed was wrong, that his dismissal was right, and that he is now making capital out of circumstances. We need only remark that these subtle impressions are utterly without weight, and that we must judge of the late Chief Constructor by his course of action, to which no exception can by any possibility be taken as evidence, by the published correspondence, and especially by the correspondence which took place after his connexion was entirely severed with the Government. Nothing could be more satisfactory than the wording of those letters, nothing more conciliatory, convincing, or showing more desire to do the country service; and those critics who affect to discover through the whole of the correspondence subtle taunt and sarcasm, too delicate to be defined, and possible only for such a master of his pen as Mr. Reed, or those who find in it a spirit of exultation over the Admiralty misfortunes, must surely be gifted with a sense of discernment out of the line entirely.

We believe that Justice will never succeed in adjusting her balance with the late Chief Constructor in one scale and the Admiralty Lords in the other, but we may point out that, great as is Mr. E. J. Reed's ability as a naval constructor, it is still greater as a politician, and that his antagonists show themselves scarcely worthy of his steel. No one can forecast the future, so big with great events, nor venture to predict that the time may come that Mr. Reed will ever re-enter the Admiralty, armed with higher power, than he possessed before he was dismissed last year, and yet how simple a combination of events may bring this matter about. Meantime, we ourselves are becoming rather weary of Mr. Reed and his Admiralty disputes, and while we wish heartily that the latter had done their duty to the country by not expelling one of the best constructors that ever held office, we most sincerely desire to see a responsible successor established in his place, and public confidence no more abused. And if accident should restore to us Mr. Reed in an official capacity, we believe that his merits and his capabilities will be more fairly rated than they have been yet. Meanwhile, however, he finds plenty of occupation in designing armour-clads for Germany and for Russia.

OUR COAL SUPPLY.

THE general report of the Royal Commission, appointed rather more than five years ago to inquire into our national coal supply, has at last made its appearance, and although it cannot by any means be said to afford a definite reply to the important question of how long our supply will last us, yet it contains, with its appendices, a vast amount of exceedingly valuable information of great public interest, and which is likely to prove of service in

years to come. It would be impossible, within the space of a single article, to do even approximate justice to the labours of the committee, and we shall, therefore, in the present notice, confine our remarks to some of the more salient points of the general report, leaving the details furnished by the reports of the sub-committees for subsequent consideration. In the first place, however, it may be desirable that we should state briefly the history of the Commission.

The first really logical discussion of the facts relating to the duration of our supply of coal was that contained in Mr. Edward Hull's book on "The Coalfields of Great Britain," published in 1861, and the arguments advanced in this work having excited much interest, Sir W. G. Armstrong brought the matter prominently before the public in his address delivered by him as President of the British Association, in 1863. Two years later, also, Professor Jevons dealt with the subject in his well-known work on "The Coal Question," and subsequently the matter was discussed by the press and in Parliament, until, on the 12th of June, 1866, Mr. Hussy Vivian moved for the appointment of a Commission. This "Commission to inquire into the several matters relative to coal in the United Kingdom" was appointed on the 28th June, 1866, with instructions to ascertain and report upon the quantity of coal contained in the coalfields of the United Kingdom, and the quantity of such coal which may reasonably be expected to be available for use; to report whether it is probable that coal exists at workable depths under the Permian, new red sandstone, and other superincumbent strata; to inquire as to the quantities of coal used in manufactures and for the purposes of commerce, as well as that exported; and, finally, to report whether coal is at present wasted by carelessness or by the neglect of proper appliances for its economical consumption. A very broad field of inquiry was thus placed before the Commission, and at their first meeting they agreed upon the expediency of organising a division of their labours by appointing a series of five sub-committees, of which the first (A) was to report on possible depths of working; the second (B) on waste in combustion; the third (C) on waste in working; the fourth (D) on the probability of finding coal under the Permian, new red sandstone, and other superincumbent strata; and the fifth (E) on mineral statistics. At a later meeting, held in October, 1866, it was further agreed to divide out the United Kingdom into thirteen districts, and to assign the task of determining the quantities of coal in these districts to separate members of the Commission. Subsequently it was found expedient to subdivide the geological inquiries assigned to Committee D, and allow some of them to be carried out by gentlemen not members of the Commission, and thus ultimately twenty-three branches of inquiry were organised and carried on simultaneously. Still more recently a sixth and a seventh committee were appointed, the former, named in December, 1868, having to perform the duty of selecting maps and obtaining Treasury sanction for their publication, while the seventh committee—which was established as recently as March of the present year, and which consisted of Sir W. G. Armstrong, Mr. Woodhouse, and Professor Ramsay—performed the task of drafting the general report, which we must now proceed to notice.

The first section of the report deals with the probable depth to which it will be possible to work our coal. The Commissioners refer to the fact that in this country the temperature of the earth is constant at 50° Fahr., at a depth of about 50 ft., and that beyond this depth the temperature increases at the rate of about 1° Fahr., for each 60 ft. in depth. In a well ventilated mine, the air will, of course, always be at a somewhat lower temperature than the strata with which it comes in contact, this difference of temperature depending upon the length of the air ways, the quantity of air by which they are traversed, and to some extent also upon the system of working adopted, the "pillar and stall" system appearing to facilitate the heating of the air by contact with the coal to a greater extent than the "long wall" mode of working. In working extremely deep pits the tendency would, of course, always be to employ as few shafts as possible, and this again would cause an increase in the length of the air ways, or in other words an increase in the amount of heating surface to which the air would be exposed. On the other hand, however, there is the probability that as the age of a colliery increased the temperature of the surfaces of its air ways would diminish to some extent, owing to the cooling down of the adjacent strata and the comparatively slow communication of heat from the surrounding masses; but at present there appears to be an absence of such sufficiently exact data as would enable any definite conclusions to be arrived at as to the rate of such cooling. With regard to the temperatures at which it is possible for human labour to be carried on, the sub-committee (A) collected some very interesting evidence, but although this evidence went to show that for brief intervals and under circumstances where cool air could be quickly reached, manual labour had been, and is, carried on under exceedingly high temperatures (reaching in some cases 180°), yet the general medical testimony is to the effect that except for very brief periods, labour is not practicable in *moist* air of a temperature equal to that of the blood, namely, 98°. Much of the evidence goes to show the important extent to which the amount of moisture in the air influences its effect at high temperatures upon the human system, and inquiries were therefore instituted to ascertain the hygrometric condition of air in mines. The results of these investigations tended to show that although the air was always humid at the working faces, yet that in general the deepest collieries were the driest; but no definite relation was established between the depth and hygrometric state.

At the rate of increase to which we have already referred, the temperature of 98° would be reached by the strata at a depth of about 3000 ft.; but inasmuch as with the long wall system of working a difference of 7° has been found between the temperature of the air and that of the working face, a further depth of 420 ft. might be assumed to be necessary to cause the air to require a temperature equal to blood heat, thus making the maximum workable depth 3420 ft. The Commissioners themselves state that the conditions affecting the temperature at this depth are in a great measure speculative; "but looking to possible expedients which the future may elicit for reducing the temperature, they considered it might fairly be assumed that a depth of at least 4000 ft. might be reached." This conclusion is used as a basis for subsequent calculations.

With regard to waste in working, the Commission are of opinion that at present great waste does undoubtedly exist, the loss in working, &c., amounting in many instances to 40 per cent., while under favourable circumstances the loss is about 10 per cent. It is satisfactory to know, however, that some improvement is being made in this respect, particularly with regard to the more extensive adoption of the long wall system of working.

The quantity of coal which is at the present time, or may be in future, available in the United Kingdom, may be divided into four portions, as follows: 1. The coal available in the known coalfields at depths less than 4000 ft.; 2. Coal in the same districts at depths exceeding 4000 ft.; 3. Coal underlying the Permian and newer strata at depths less than 4000 ft.; and 4. Coal underlying the Permian and newer strata at depths of from 4000 ft. to 10,000 ft. As regards the coal belonging to the first of the above-mentioned classes, the reports of the various Commissioners give the following quantities as available after the necessary deductions have been made, seams less than 1 ft. thick being disregarded:

	Tons.
England and Wales	80,208,139,468
Scotland	9,843,465,930
Ireland	155,680,000
Total	90,207,285,398

The Commissioners reporting on Scotland and Ireland make no mention of supplies under known coalfields at a greater depth than 4000 ft., but the reporters for England and Wales give 7,320,840,722 tons as existing below that depth under the known coalfields. As regards the deposits under the Permian and newer strata at less depths than 4000 ft., the estimates are as follows, 40 per cent. being deducted for loss and other contingencies:

	tons.
England and Wales	56,246,000,000
Scotland	no estimate
Ireland	27,000,000
Total	56,273,000,000

Investigations were also made by Committee (D) as to the probability of the existence of coal in districts where its presence has not been discovered during mining operations, and is not indicated by the outcrop of carboniferous strata in the immediate neighbourhood, particular attention being paid to the probability of finding coal in the south of England. A review of the whole subject is made by Mr. Prestwich, who in the main supports the views of Mr. Godwin Austen, and concludes that there is a high probability of productive coal measures underlying the secondary rocks of the south of England, while he also shows that there are grounds for believing that coal exists at the south side of the Mendips, and under adjacent parts of the Bristol Channel, but at depths of not less than 1500 or 2000 ft.; while he also mentions a new coal basin of small extent near New Passage, in the Severn Valley. The probability of coal existing under the Cretaceous and other secondary rocks in the south of England is, however, earnestly protested against by Sir Roderick Murchison, and as the question is still one of theory, no attempt has been made to estimate the quantity which might thus be found.

The last portion of our coal considered in the report, is that underlying the Permian or newer strata at depths of from 4000 to 10,000 ft. This quantity is computed as about 41,144,000,000 tons, of which about 29,342,000,000 tons lie at depths between 4000 and 6000 ft. Adding to this 41,144 millions of tons, the 7320 millions of tons estimated as lying at depths exceeding 4000 ft. within the area of the known coalfields, we get the total estimated quantity of coal at depths below 4000 ft. as 48,465 millions of tons. On the other hand, of coals at a less depth than 4000 ft. within the area of our known coalfields we have already stated the estimated quantity to be 90,207 millions of tons, which added to the 56,273 millions of tons, similarly situated under the Permian and newer strata, gives altogether 146,480 millions of tons as available at less depths than 4000 ft. This, then, is the supply with which we have to deal, let us now examine how long it is likely to last.

In dealing with this question, the Commission have necessarily had to make certain assumptions, and it is upon the accuracy of these assumptions that the value of their predictions as to the duration of our supply of coal, of course, depends. Very wisely, however, the Commissioners have not ventured to make any definite prophecy, but have rather endeavoured to state fairly the circumstances which may modify the duration of our coal supply, and the influence of those circumstances, leaving to the general public to decide what set of circumstances is most likely to occur. For many years past the increase in our consumption of coal has been due not merely to an increase in our population, but also to the fact that the quantity of fuel consumed per head has become much augmented. Thus, whereas in 1855 the population of the United Kingdom was 21,792,872, and the quantity of coal retained for home consumption 59,330,557 tons, or 2 tons 14 cwt. 0 qrs. 5 lb. per head; in 1862, with a population of 23,416,264, the home consumption had reached 75,202,986 tons, or 3 tons 4 cwt. 1 qr. 2 lb. per head; and, in 1869 (the last year for which complete returns have yet been made), with a population of 25,075,088, the amount of coal retained for home use had become 97,066,499 tons, or 3 tons 17 cwt. 1 qr. 19 lb. per head. Arguing on such facts as those to which we have just referred, Professor Jevons, in 1865, estimated the growth in our coal consumption as amounting each year to 3½ per cent. of the consumption of the preceding year, a system of calculation which would give an annual consumption of 2607 millions of tons per annum at the end of a century, and would lead to an exhaustion of our supply in about 110 years from the present time.

Luckily for succeeding generations, however, there seems little reason for supposing that such a calculation possesses even an approach to correctness. One thing amongst others which tends to upset such a conclusion as that just mentioned consists in the fact that although our population is annually increasing, yet that the *rate* of this increase is diminishing. The attention of the Commissioners was specially directed to this fact, and the results to which it leads, by Mr. R. Price Williams, who has contributed to the report several interesting Tables bearing upon the subject. Mr. R. Price Williams is of opinion that the present rapid increase in our consumption of coal is mainly to be attributed to "the equally rapid and abnormal development of our commercial activity, which has followed the introduction of steam power in this country; and that the effect of this initial increase

in the yield of coal is still perceptible, just as it is, in a minor degree, in the present rate of increase of our population." Mr. Price Williams further considers that there will be a decrease in the rate of increase of the consumption per head of the population; or, in other words, that the point of maximum rate of increase has been already past, while arguing upon these premises he assumes that the supply of coal at present supposed to be available at depths of less than 4000 ft. would be sufficient for 360 years to come, at which time the consumption would have reached 612,800,000 tons per annum, and the population 131,700,000 souls. We may take the opportunity of remarking here that this estimate of Mr. R. Price Williams, as well as those of the Commissioners to which we shall allude directly, are, to avoid complication, all made on the supposition "that the production of coal could continue in full operation until the last remnant was used, and then suddenly cease." As the Commissioners remark, however: "In reality a period of scarcity and dearness would first be reached. This would diminish consumption and prolong duration, but only by checking the prosperity of the country."

If, in place of assuming a geometrical increase in the rate of consumption, it be supposed that the increase merely takes the form of a certain constant additional quantity per annum, we get very different results from those above stated. Thus assuming the increase to be at the rate of 3,000,000 tons per annum, the Commissioners remark that at the end of a century the consumption would be 415,000,000 tons per annum, and the quantity of coal at present supposed to be available at depths of less than 4000 ft. would last but 276 years. Finally, the Commissioners consider another view of the matter, which is directly opposed to that of Professor Jevons. This supposition is, that from the present time "the population of the whole country, and the consumption per head of that population, will remain constant, or merely oscillate without advancing. In this case our available coal would represent a consumption of upwards of 1273 years at the rate of 115,000,000 of tons per annum."

If now, instead of taking the coal available at depths of less than 4000 ft. as our basis of supply, we add to that quantity the amounts estimated to exist at lower levels, namely, 48,465 millions of tons, it will be found that the 360 years' duration calculated in Mr. Price Williams's data will be increased to 433 years; the 276 years, derived from the assumption of the consumption increasing in arithmetical ratio, will become 324 years; and, finally, 1273 years' supply, based on the supposition of non-increasing consumption, will be augmented to 1695 years.

Altogether the duration of our coal supply is a matter subject to modification by so many contingencies which it is impossible to foresee, that it would have been idle on the part of the Commission to have attempted — and certainly idle on the part of any one else to attempt—a definite solution of the problem. On the whole, we consider that the balance of probabilities is in favour of Mr. R. Price Williams's calculations proving tolerably correct for some few years to come, although we greatly doubt whether his ratios of increase will prove to be applicable for anything like the periods given in his tables. We believe that as our increase of population goes on, the *rate* of increase will diminish in a far more rapid ratio than it does at present, and that ultimately there will be established a state of affairs approximating closely with that assumed in the last supposition considered by the Commission, or, in other words, that increase will cease altogether. As with the population, so we believe it will be with the consumption of coal per head per annum. As new applications for steam power are discovered, so will the use of coal increase, until at last we may suppose a point to be reached when steam is used for every purpose to which it is applicable, and from the moment of that point being attained there will be a decrease of coal consumption, consequent upon the introduction of improved appliances for utilising the power developed.

We have so far made no allusion to the chance of steam power being altogether superseded before our coal supply approaches exhaustion. It must be remembered, however, that there is always a chance of this, although it is impossible to found any argument upon it. Finally, it must be borne in mind that the rapid development of intercourse between different countries, and the opening up of coalfields abroad will exercise an important influence upon the future coal supply of this country, not only by diminishing our exports of coal, but by rendering it possible for raw materials to be profitably worked up near the source of their supply, instead of being sent here to be brought into a manufactured state. Ultimately, indeed, it may be found that the wealth of Great Britain does not consist in her coal supply, but in the possession of men having the knowledge and energy necessary to turn to good account the resources of Nature whenever they may be found.

OPENING OF COOPERS HILL COLLEGE.

THE Indian Civil Engineering College at Coopers Hill has at last become an established fact. Conceived, in the strictest sense of the word, in the interest of India, with the view of raising up a body of men who shall design and construct her public works of the future, who will have been educated with the special object of becoming engineers in the true practical sense of the term, and particularly trained with reference to the special requirements of India, it would have been thought that no apology would have been required from its promoters for the establishment of such an institution. Such, however, was not the case. The existence of a college especially designed for the education of engineers, could not but enter into a dangerous competition with those colleges where such education is now partially carried on. The quicksands of opposition, however, being safely passed over, the inauguration of such an establishment was an occasion well worthy of some ceremony. Accordingly, on Saturday last, a select party of ladies and gentlemen, numbering altogether, including the college professors and students, about 200 persons, went down by special invitation to Coopers Hill to be present at its official opening by the Secretary of State and Members of Council for India.

Before entering into any particulars of the ceremony and speeches on that occasion, it may be interesting to give some brief description of the building itself. When Coopers Hill estate was purchased by the Indian Government for the purpose of establishing there a civil engineering college, there was already on the site a mansion of considerable size, containing about 100 rooms, erected within the last few years by Messrs. Myers, from the designs of Messrs. F. and H. Francis, architects, surrounded by a park and gardens, altogether 121 acres in extent. This building the Indian Government placed in the hands of their architect, Sir M. Digby Wyatt, who, by certain alterations and additions to the existing structure, and the erection of an extensive new block, has provided an institution capable of accommodating 100 students at present, with a prospective increase to 150, each of whom will have a separate room. In addition to this provision for students, there are, taking the old and new blocks together, very complete arrangements for the prosecution of their studies in the various scientific branches of the college course. Amongst the various rooms we observed four class rooms measuring 30 ft. × 30 ft. 6 in.; 18 ft.×25 ft.; 25 ft.×30 ft.; and 22 ft.×27 ft. respectively; library, 20 ft.×50 ft.; reading room, 20 ft.×16 ft. 6 in.; model room, 20 ft.×23 ft.; lecture theatre, 29 ft. 6 in.×47 ft.; dining hall, 22 ft.×60 ft. 9 in; laboratory, 25 ft.×20 ft.; billiard and recreation room, 22 ft.×34 ft.; kitchen, 24 ft.×30 ft. 6 in.; servants' hall, 18 ft.×24 ft. Besides these rooms and the requisite domestic offices, servants' rooms, laundry, &c., accommodation is provided in the mansion for the president, one married and three unmarried professors; other members of the staff of professors being housed in five residences, comprising one detached and four semi-detached houses now being erected on the estate. The works, which were commenced on the 1st February last, are being carried out by Messrs. Ashby and Horner. Formerly, this mansion was supplied with water from wells on the estate, but in consequence of the great demand that will now be made upon them, it has been thought desirable to augment that supply by laying down pipes from the water works near Old Windsor.

Amongst the visitors at the opening ceremony we noticed Sir Stafford Northcote, late Secretary of State for India; Right Honourable Sir E. Ryan; Lieutenant-General Sir Duncan Cameron, K.C.B., Governor of Sandhurst; Major-General Napier, Director-General of Military Education; Colonel Hamley, C.B., Commmandant, Staff College; Sir Macdonald Stephenson; Messrs. C. Hutton Gregory, C.E.; E. Woods, C.E.; W. Parkes, C.E.; G. Preston White, C.E.; W. T. Thornton, Secretary, Public Works Department, India Office; Juland Danvers, Government Director of Indian Railways; Sir M. Digby Wyatt; Major Champain, Director of the Indo-European Telegraph; Lieutenant-Colonel Strange, Inspector of Scientific Instruments, India Store Depôt, &c. &c.

The Duke of Argyll, in his opening address, referred to a remark made by Lord Ellenborough some years ago, that if by any accident the British should be expelled from India, they would leave almost nothing behind them in the way of great public works to distinguish the period of their rule. This, though well founded at the time, could not now be regarded with truth. Attention to public works dated mainly from the viceroyalty of the Marquis of Dalhousie; and we have now completed, under a system organised and devised by him, a chain of railways which ran up the whole valley of the Ganges, from Calcutta to Lahore, connecting also the western coast of India with this great valley of the Ganges. In India, everything in connexion with public works is done by Government, obliging them to maintain a permanent staff of civil and military engineers. After referring to the failure of the competitive system, which was first established by Lord Stanley in 1859, His Grace commented on the want of proper means for engineering education in this country, quoting extracts from the pamphlet recently published by the Institution of Civil Engineers, on scientific education at home and abroad, to prove his position. With regard to the College, he remarked that it was no close monopoly, but that entrance to it was open to all the world; and his speech wound up with an exhortation to the students to avail themselves to the utmost of the advantages now placed within their reach, and to learn to cherish the utmost respect and affection for the natives of India. This address, which was in the nature of an explanation of the reasons that had led to the establishment of the College, was followed by one from Colonel Chesney, the Principal of the College, in which he explained the course of education proposed to be carried on there, respecting which we may have something further to say on a future occasion.

The staff of professors at present appointed consists of the following gentlemen:—Lieutenant-Colonel G. Chesney, R.E., Principal; Callcott Reilly, Esq., M.I.C.E., Professor of Construction; Rev. J. Wolstenholme, Professor of Mathematics; H. McLeod, Esq., Professor of Physical Science; Captain W. H. Edgcome, R.E., A.I.C.E., Professor of Surveying; Lieutenant G. S. Clarke, R.E., Instructor in Mechanical Drawing; Cotton Mather, Esq., Lecturer in Hindustani; and S. Evans, Esq., Instructor in Landscape Drawing. It will thus be seen that the Royal Engineers have secured to themselves already a very fair proportion of the good things of the college, and probably we shall find, when the staff is brought up to its full complement, a few more Royal Engineers added to the number of the professors. We are not led to make these remarks from any spirit of hostile criticism, but we doubt whether employment on professorial studies is the proper occupation for the members of that corps. Something may, no doubt, be said, and with great truth, to the effect that the Indian Engineering College furnishes an exceptional case, and that engineer officers who have held similar appointments in India will be found best suited for the appointments now held by them at Coopers Hill. With this we perfectly agree. Considering that India is governed and held by the sword, a military officer of Indian experience is unquestionably the proper person for the principal of this new college, and a still further infusion of Indian military experience may not be undesirable under the peculiar circumstances of the case. It is, however, to the results that we must look as a justification, not only for the selection that has been made in appointing professors and teachers, but also for the establishment of the college itself. We have from the first expressed ourselves strongly in favour of the establishment of this college, as being a means to an end which it had become necessary to attain, viz., a regular supply of well-trained engineers for service in the Public Works Department of the Government of India. That its progress will be closely watched and criticised, cannot be doubted, and it must be remem-

bered that this is a case in which it may truly be said that the end only can justify the means.

We must not conclude this notice of the opening of Coopers Hill College without recording our acknowledgments to the great courtesy we experienced from, and kind assistance given to us by, Captain B. D. Danvers, secretary to the college, who was indefatigable in his exertions to promote the success of the opening ceremony, and to furnish us with all the information in his possession.

It had been originally proposed that the students who have recently gained admission to the college by competitive examination should commence their studies on the 8th instant, but owing to the present incomplete state of the building, we understand that they will not be now required to enter upon residence there until the 12th of September.

THE INSTITUTION OF CIVIL ENGINEERS.

SINCE the Royal Charter of Incorporation was granted to the Institution of Civil Engineers, on the 3rd of June, 1828, the scope of the profession has expanded beyond all the anticipations of those great early engineers who founded the Association. Although Telford's celebrated definition holds good in all its force—that civil engineering is the "art of directing the great sources of power in Nature for the use and convenience of man"—it is a proof of the astuteness and prevision of those who framed the bye-laws of the Institution that they have held good ever since they were originally laid down, and that, even at the present time, they require no modification. The circular, however, which has just been issued by the Secretary of the Institution is one that calls for some little attention, bearing, as it does, upon so important a point as the qualification of candidates. It is urged in the circular that, while the provisions of the bye-laws, if strictly adhered to, are amply sufficient to insure the admission only of those who are qualified for the distinction, and are restrictive enough to exclude those who would not prove suitable members of the Institution, it is absolutely necessary that a strict attention should be given to the spirit of those laws. The circular alluded to contains, in fact, a caution to those whose privilege it is to introduce within the circle of fellowship those engineers who seek to partake of the many advantages the Institution has to offer. And this caution is rendered all the more necessary on account of the large and increasing number of applications for admission to one or other of the Institution grades. So long as the absolute spirit of the bye-laws is adhered to, and proposers and seconders of candidates stand as sponsors solely from personal knowledge, nothing is left to be desired. We believe, however, it must be admitted, that of late years something of laxity has crept into vogue, and that seconders will often, actuated by kindly feeling, attach their names to a candidate's application, acting, not by personal knowledge, but taking their information at second hand. To check this practice is, we take it, the chief object of Mr. Forrest's circular.

But while it is the duty of the secretary of the Institution—and a secretary more faithful, zealous, and judicious never administered the affairs of any public body—to point out to the members and associates the probable evils which would arise from a too free and indiscriminate use of the privileges of their member or associateship, it is in our power to speak of the status of the Institution, the good it renders, and the influence it has had on the profession. Glancing through the long list of members, and the larger list of associates, we cannot deny that there are some few names that should be altogether expunged, and very many shifted from the lower to the higher grade. But let the most determined caviller at the Institution consider the difficulties in the way of selection, and he will, if he can judge fairly, be constrained to admit that there never existed a society, with no protection except the judgment of its members, that shows evidence of so liberal, and withal, so just a spirit as the Institution of Civil Engineers. Having no assistance from without, such as is rendered to other professions, by specified examinations, which decide qualification, the Institution has nevertheless preserved its identity perfect through its long life, a result which could never have been achieved except by the greatest care and judgment. And, indeed, it is difficult to see how, even if the profession of engineering were duly qualified, as others are, that any different results would ensue. It would always happen that a few incompetents would be elected, that the rules for admission would fix the position of some engineers who would be eminently suited for membership, in the lower grade of associates, and if, as the profession develops, prescribed examinations should ever help to decide in some degree for the Council, the proper rank of candidates, the advantages obtained would in our opinion be more than counterbalanced by drawbacks. At all events it is no duty of the Institution to become an educational body; its province is to advance the profession, by the assistance of its members, to place on record as far as possible all the important features of engineering progress, and to extend itself until it embraces all who are fitted by their capacity to aid in this work, independent of nationality. The enrolment of foreign members is one of its most important duties, in order that specialities of practice may become familiarised, and the profession be made, as it should be, cosmopolitan. It need, however, hardly be pointed out that the election of foreign candidates should be conducted with even more than ordinary care, and that seconders for such should be found who can answer thoroughly for the qualifications of those seeking admission. And, indeed, this remark applies with equal force to English engineers established abroad. It is not sufficient that evidence should be adduced conclusive of their ability before they quitted this country. A career abroad involves fresh labours, strange responsibilities, and the capacity for fulfilling these requirements must be satisfactorily attested.

A few words may be said in reply to the various criticisms which are sometimes made upon the government of the Institution. We have heard it urged before now that a party spirit, even a spirit of unfairness, is not unknown in the Council. Among so many members as the Institution now contains, it would be wonderful indeed if dissatisfaction were not to be found; but the actions of the Council have to be judged by their results, and it is sufficient to point out that there exists nowhere any great society, bound together only by internal cohesion, exercising so great an influence for good, so free from meanness in its administration, from trade influences in its proceedings. There exists no society which has exerted a greater power for good in the profession of which it is the head, none which can look back through a long career with more pride, nor forward to a longer future with more hope than the Institution of Civil Engineers.

NOTES FROM PARIS.

PARIS, August 7, 1871.

THE RAILWAY COMPANIES.

Two great railway companies have held their general annual meeting during the past week, the date having been necessarily deferred by the recent events. The Orleans Company had in operation, during the year 1870, about 2500 miles, out of a total authorised mileage of 2700; but few new lines have been constructed. The traffic receipts show a total of 121,300,000 francs, less by 5,200,000 of that in 1869. The net product of working has been only 57 million francs instead of 66 millions as in 1869. The shareholders will receive a dividend of 43 francs, plus 7 francs that will be carried to a reserve account. The Paris, Lyons, and Mediterranean Company possessed at the end of 1870 a network of 3880 miles, of which 2720 were opened to traffic, 421 in course of construction, and 739 remaining to be made: the length opened for traffic during the year amounted to 128 miles, but the expenditure of capital was only 26 million francs as against 59 millions in 1869. The receipts for the year were about 211,700,000 francs, whilst in 1869 they reached 218,800,000; the expenses, on the contrary, were 75,200,000 against 73,300,000 in 1869, showing for the net product a reduction of 9,500,000 francs. The dividend has been fixed at 40 francs per share.

THE MESSAGERIES MARITIMES.

The Messageries Maritimes Company has also held its general meeting, on the 1st of August. The year 1870 showed a total of receipts from all sources of about 42,900,000 francs, with an expenditure of 38,400,000, leaving a balance of 4,500,000 francs. There will be announced a dividend of 27.50 francs on the original stock, and 13.50 on the new share capital.

THE FINANCIAL SITUATION.

The balance-sheet of the Bank of France shows this week a slight improvement in the financial situation; the payment of the war indemnity continues rapidly. Paris, since the new municipal council has been established, is occupied with the liquidation of liabilities which the preceding régimes had bequeathed to it; the tax regulations are submitted to elaborate discussion. With such grave material interests at stake, and with the most delicate political questions at the same time unsettled, it is not surprising that the activity of business does not recover itself so rapidly as had been at first hoped. It must be admitted, indeed, that during the past fortnight there has been shown an evident heaviness in the recovery of affairs. The prices of wrought and cast iron are maintained, but that is owing rather to the inefficiency of transport than to the presence of orders. The price of coals is also maintained, though there is comparatively little business done in them.

THE LATE M. SOMMEILLIER.

The Society of Civil Engineers have recently lost one of their most eminent members, M. Sommeillier, whose name will always remain connected with one of the greatest engineering works of the century—the Mont Cenis Tunnel. This French engineer, under the patronage of the Count de Cavour, put into operation the machines he had invented for boring the tunnel, and he learned how to give to his invention, as the work advanced, the improvements which resulted in complete success. He lived to complete his work, but not to assist at the inauguration of it.

THE LATE M. MANIEL.

The Corps des Ponts et Chaussées has recently suffered a great loss by the death of M. J. Maniel, one of its youngest inspectors-general, and for many years secretary of the Council General des Ponts et Chaussées. Born in 1813, M. Maniel took first honours in the Polytechnic School in 1834. Since 1841 he was appointed by the State in the construction of the Northern Railway. The company chose him afterwards as engineer-in-chief of works. In 1855, the Association of State Railroads in Austria confided to him the direction of this great enterprise, which comprises besides the construction of a vast network of railroads, the design and organisation of important metallurgical and industrial establishments. These manifold and arduous duties he fulfilled for ten years with great success. Returning to France he took an important part in several great railway undertakings, and then re-entered Government service. His great ability, the independence of his character, the experience in business which he acquired in so busy a career, and the justness and extent of his ideas would have made him in the future still more useful to his country had he been spared.

PORTABLE RAILWAYS.

THERE are in existence railways of all dimensions, from the great lines that transport passengers by millions, to the modest mineral and workshop tramways for the transfer of iron and coal, or of materials in course of transformation. The more the cost of the latter can be reduced, the more one learns the value of narrow gauge lines and the extent to which they can be applied. There are innumerable cases where there would be great advantages in diminishing the rolling resistances, but where the trifling importance of the loads to be moved does not permit the construction of a line of the most limited dimensions and the most economical character. There is at this moment being constructed at the works of a wagon builder at Ivry near Paris, a kind of portable railway, intended for the conveyance of material in a sugar factory, and the lightness, simplicity, and low price of which would appear to combine the desired results. The way consists of a series of trestles about 17 ft. span. These are placed on the ground without levelling it in any way, and the spans are coupled together at their ends by a pin passing through an iron box at each end of every trestle. A flat iron bolted to the upper part of the horizontal bars of the trestles forms the rail. Each span of 17 ft. weighs only about 45 lb. so that they are easy to take up and lay down. By them a temporary iron road can be rapidly established which follows the natural contour of the ground over which it passes. The carriages intended to carry each from 100 lb. to 220 lb., form a series of rolling platforms. They are articulated one to the other, and carry baskets on each side, in which the material to be moved is deposited (such as beetroots, pulp, coal, &c.) They are attached to the platforms each by four iron brackets. By this there is obtained for about 2s. a yard an iron road on which a horse can haul on a level about 20,000 lb. It is hoped that this arrangement will play an important part in the transport of agricultural produce, and that under certain circumstances it may be applicable with economy to the transport of goods.

SIR FRANCIS PETITT SMITH.—We have pleasure in announcing that the honour of knighthood has been conferred on Mr. Francis Petitt Smith, as a recognition of his labours in connexion with the practical introduction of the screw propeller.

STEAM FIRE ENGINES FOR THE HAGUE AND ROTTERDAM.—Messrs. Merryweather and Sons have just completed two steam fire engines for the above places. The authorities at the Hague have had the purchase of a steam fire engine in contemplation for over twelve months, and after carefully discussing the merits of the engines produced both by English, American, and Continental manufacturers, they decided on the class of engine produced by the above firm. The points chiefly looked to were those which these makers have specially studied to bring forward, and that is, simplicity, durability, and facility of management of the machine in the hands of a man who may not be a mechanic, as well as the accessibility to all parts of the engine in case repairs are needed. The Hague engine at its preliminary trial discharged 300 gallons per minute to a distance of 180 ft., and through 4 jets to a distance of 105 ft. The Rotterdam engine is similar to that supplied by Messrs. Merryweather and Sons to that town some six years since, with the exception that it discharges 25 per cent. more water in the same time.

DISINTEGRATING GRAIN.

*Carr's Patent Disintegrating Flour Mill. A New System of Reducing Wheat, &c., to Flour.**

By THOMAS CARR.

In what manner grain could be best prepared for the manufacture of that all-important requisite bread, so appropriately termed the "staff of life," has been one of the grand problems that has from the earliest ages excited the interest and ingenuity of successive generations.

To the early pestle and mortar, or rude quern, succeeded the millstones, but to the latter for thousands of years man's inventive genius seems to have been chained, as no change till now of a radical or fundamental character has been introduced in mills for the reduction of wheat into flour, the identically same description of mills (differing scarce in anything but in their increased size, and the substitution of wind, water, or steam to drive them in place of manual labour), being still in as universal use throughout the world as they were in those days of remote antiquity. It is true modifications from time to time have been suggested, but only very partially adopted, and in most cases the reason for their non-adoption has arisen from the fact, that while the principles involved directly or indirectly in the action of the mill stones, are not merely multitudinous and complex (and yet singularly harmonious in action), the mill itself in which they are embodied, is characterised by a most admirable simplicity in material construction, such as the schemes intended to supersede them do not possess, since the chief of the alleged improvements are made at the sacrifice of this last all-important requisite, viz., simplicity in material and construction.

Thus there is the Hungarian system, invented some 60 years since, in which, with the object of avoiding any intermixture of powdered bran with the flour, the kernels are first decorticated or "hulled" clean, and then rasped into flour between a complicated series of different speeded fluted rolls, a tedious system, involving some seventeen processes to complete the operation, and great cost in repairs, a modification of which plan was not long since patented in England. Again, there is the directly opposite plan patented by Chapman and Co., for their entire wheat flour, in which the bran is ground by a second operation into an impalpable powder, and then mixed with the ordinary flour, the result being a flour much resembling very fine oatmeal in colour, taste, and smell, but claiming to be highly nutritious and wholesome. Again, there is the plan of French origin, in which it was proposed to dispense with grinding entirely, the wheat, after decortication, being softened by maceration in water, and crushed by rollers into dough ready for making into loaves, a system in part pursued by Brown and Polson in the manufacture of their patent corn flour from maize.

Now, it will be observed that all these modes of reduction, both ancient and modern, are based on one system, which (with the exception of the machines I am now going to describe) universally characterises every mill and pulverising machine in the world, no matter to what purpose they are applied; and that is, that at the precise moment the material is being operated on, it invariably intervenes between, and is simultaneously in contact with, two working surfaces, one or both of which then support or hold it.

To illustrate this, such familiar examples as these may be adduced: the upper and nether stones of the before-named old flour mill, the pair of parallel rolls of a crushing mill, the pestle and mortar, the edge runner and pan, and many others.

In Carr's patent disintegrating flour mill, which it is the object of this paper to introduce to your notice, the reverse of all this is the case.

It consists of a series of beaters,† formed of bars with open spaces between them, arranged cylindrically on disc plates, around and parallel with a central axle. Into these disc plates one end of each bar is rivetted, so that the bars stand at right angles to the faces of the discs, while their other ends are rivetted into rings, which so tie them that each bar is supported by the aggregate strength of the whole.

These cylindrically arranged beaters (forming what I call cages, from the slight resemblance they have to squirrel cages), are of different diameters, so that when placed as they are, concentrically one within the other, sufficient spaces may intervene between to isolate each, and give them the requisite clearance, and thus prevent any scrubbing or grinding action on the material which might ensue between them if they were rotating in too close proximity.

These sets of beaters, of which for flour fourteen are used, are driven by means of an open and a crossed strap with extreme rapidity in contrary directions to one another right and left alternately.

The wheat flows in at the central orifice, and is thrown out by centrifugal force from the first cage at a tangent to its circle, and at a speed equivalent to that at which the beaters of the said cage are rotating; where meeting the beaters of the next cage moving in an opposite direction, its direction is reversed, and it is again thrown outwards to meet the beaters of the third cage, also moving in a contrary direction; and so on with the other cages until (and that in less than a second from the first introduction), the fragments, reduced to fine flour, semolina, and bran, are delivered in a radiating shower, alike from every part of the periphery into a surrounding casing, all the beaters (of which there are about 1000) being thus simultaneously effective, and the balance of the machine maintained.

Thus, though with these different sets of beaters, each acts independently, they are so arranged relatively to one another, that not only is a repetition of the blows on the same material thereby obtained, as many times repeated as there are different sets of beaters, but the centrifugal force generated by the rotation of each set is caused to throw the material from the first set of beaters, and dash it with great violence against the second, and in like manner against the third; and so on in directions the reverse of that in which the successive sets of beaters it strikes are moving; by which means the blows are enabled to act with redoubled energy on the separated particles of matter as they are discharged against them, precisely in the same way that stones are hurled from a sling.

An artificial momentum is thus given to the material as well as to the beaters, and that in direct opposition to each other, such as is the case with a cricket ball and bat; but of course to an immeasurably greater extent, for when the material and the beaters meet, it is the sum of the two speeds added together which produces the shock; in which collision the motion of the material is totally annihilated, and a fresh projectile force at the same instant given it in an opposite direction.

Thus, when the speed of the machine is increased, as in doing so the momentum of the material increases with it (and that in a contrary direction) it follows that to double the number of revolutions per minute becomes equivalent to quadrupling the speed, and, as the shock is as the square, the disintegrating effect of each blow becomes sixteen times greater than before, and this is repeated and with augmenting force, in each succeeding set of beaters. On the wall are two tracings to illustrate the action of the machine. One is a sectional side elevation of rather more than half the machine, showing only (to avoid confusion) the particular bar in each cage that occurs at the line of section.

The other is a diagram of a portion of the front view, the curved arrows showing the direction in which the cages are moving,* and the straight ones, the zig zag course such an unbreakable material as a steel bullet would take in passing through the machine, the bars revolving one way are coloured blue, while those going the reverse way are coloured red.

Now a little consideration will show that with this system of free blows no friction ensues between the machine and the material, which exists to so great an extent in other mills; neither do the beaters waste their impetus on any unyielding medium like an anvil, by which the power might be needlessly absorbed, but, on the contrary, meet with no resistance except that which is strictly due to the act of overcoming the cohesive strength of the material operated on. Thus the rare desideratum is attained of having no expenditure of power beyond what is strictly equivalent to the effect produced.

Not the least noteworthy fact is the important one, that the efficacy of this machine can in no way be affected or impaired by work, what trivial amount of wear it may sustain having not the slightest deteriorating influence on its operative efficiency; and thus, in place of the tedious weekly dressings of the mill stones, it may be worked night and day without stoppage for a twelvemonth, and be, not merely in as good working order, and in every respect as efficient as in the first hour it was started, but in some respects even better, as the brasses and bearings will then be more smooth and bedded more evenly in unison with each other.

All the attention the machine requires in working it, is simply to keep the four bearings of its shafts well oiled, for there are no other rubbing surfaces whatever.

As regards the repairs it will require, they are limited to two, and these only necessary at wide intervals of time.

The first of these is that of the brasses of the four bearings above spoken of; like all other brasses they will of course require adjusting and renewing occasionally. The other is the renewing of the crucible steel beaters which may be safely estimated to be good for some ten or twelve years at least, when they could be replaced at an engineer's works in a week.

Now it is a literal and absolute fact, that there is nothing whatever else about the machine at all liable to wear out, and nothing otherwise liable to get out of perfect working order.

Carr's patent disintegrating flour mill is found capable of pulverising with care 20 qrs. of wheat per hour, and dispensing with 25 pairs of millstones. The percentage of flour obtained by it as shown by a careful analysis of the meal from it and the same wheat reduced by millstones is pretty nearly the same; but the quality of that from the new mill is greatly superior, it being shattered into a fine granular state, not "felled" or "killed" as the bakers call it, or, in other words, not rendered densely close and impervious by too fine grinding under frictional pressure.

The disintegrated flour absorbs more water, forms a raw paste of greater tenacity, and when baked, a whiter, lighter, and much better keeping bread, with the sweet nutty flavour of the wheat most agreeably preserved.

It is the only mill which has ever yet been invented that is not duplex but single-acting, in which disintegration is effected while the material is falling freely or being projected through the air unsupported; and in which no individual particle thereof, at the moment of disintegration, is ever simultaneously in contact with more than one portion of the mill, viz., the particular beater striking, and so shattering it by percussion in mid air, as a cricket-ball is struck in mid air by the bat.

It is also the only mill the mode of action of which comprises a combination of the continuous power in the mill ever flowing to it from the prime mover with projectile impetus in the material, contributing to the attainment of the end in view.

Yet widely different as these two principles are they are yoked together in the disintegrators, and, for the first time, work harmoniously. By this novel alliance, the material itself, instead of being inertly impassive as in all other mills, is made for the first time to play an active part in its own disintegration, and to virtually constitute for the time being a vital portion of the machine itself; the projectile momentum, weight, and vis inertiæ of the former comprising the sole abutment or fulcrum of the machine, whereby it is enabled to apply the power expended in driving it to the practical purposes required. There is a perpetual succession of free unarrested blows delivered by the beaters with extreme rapidity against the flying material, which is hurled against them with projectile impetus from an opposite direction by centrifugal force, and as each individual particle struck may be regarded as representing a separate and distinct blow, independent of the other particles so struck, the total number of such blows amounts to many millions per minute.

Thus the principles, mode of action, and system of disintegrating matter in the disintegrator not only bears no resemblance whatever to those of the mills, both of ancient and modern times, but it is distinguished by the total absence in it of everything appertaining to them of a fundamental character; so much so, indeed, that when we attempt to compare it in those respects with other mills we discover nothing but diametrical antagonisms to all previous processes.

In further explanation of the result aimed at in the construction of this machine, it may be necessary to describe the structure of the berry of the wheat on which it is to act. It is composed of an outer covering called bran, and an inner kernel which yields flour, but when these are subjected to the searching power of the microscope, this outer skin or bran is found to be composed of six different envelopes, each with a distinct structure; and inside of these there is a honeycomb structure of cells, lying in as regular order within the outer coatings, as it is possible for even nature to place them. These cells are separated one from another by a packing of rather softer material called cerealine.

The great object aimed at in all flour mills is to disintegrate wheat pickle in such a manner as to reduce it to fine flour without destroying its granular structure, and in proportion to the degree in which this is accomplished the nutritive properties are retained or diminished.

Now it will be admitted by all, that wheat cannot be ground in one operation into fine flour by mill stones, without destroying a considerable portion of its granular structure.

The knowledge of this has created the Austrian and Hungarian method already described, which though successful, in the production of a fine quality of flour, is expensive and tedious. By the machine under review, however, the desired result is most effectually and economically obtained.

Two of these machines are now and have been for many months in successful daily operation at Messrs. Gibsons and Walker's flour mill at Bonnington, adjoining this city, where, by the kind courtesy of that firm they may be inspected in operation by any of the members or associates, and I am confident will amply repay those interested in the machine for the time they spend in its inspection.

* Paper read before Section G of the British Association.

† We published an illustration of Mr. Carr's apparatus for disintegrating flour on page 237 of our last volume.

* It may be observed that the three inner cages move in the same way for the purpose of equal distribution.

THE BRITISH ASSOCIATION.

ADDRESS OF SIR WILLIAM THOMSON, KNT., LL.D., F.R.S., PRESIDENT.

(*Concluded from page* 69.)

RETURNING to the science of terrestrial magnetism, we find in the reports of early years of the British Association ample evidence of its diligent cultivation. Many of the chief scientific men of the day from England, Scotland, and Ireland found a strong attraction to the Association in the facilities which it afforded to them for co-operating in their work on this subject. Lloyd, Phillips, Fox, Ross, and Sabine made magnetic observations all over Great Britain; and their results, collected by Sabine, gave for the first time an accurate and complete survey of terrestrial magnetism over the area of this island. I am informed by Professor Phillips that, in the beginning of the Association, Herschel, though a "sincere well-wisher," felt doubts as to the general utility and probable success of the plan and purpose proposed; but his zeal for terrestrial magnetism brought him from being merely a sincere well-wisher to join actively and cordially in the work of the Association. "In 1838 he began to give effectual aid in the great question of magnetical Observatories, and was indeed foremost among the supporters of that which is really Sabine's great work. At intervals, until about 1858, Herschel continued to give effectual aid." Sabine has carried on his great work without intermission to the present day; thirty years ago he gave to Gauss a large part of the data required for working out the spherical harmonic analysis of terrestrial magnetism over the whole earth. A recalculation of the harmonic analysis for the altered state of terrestrial magnetism of the present time has been undertaken by Adams. He writes to me that he has "already begun some of the introductory work, so as to be ready when Sir Edward Sabine's Tables of the values of the magnetic elements deduced from observation are completed, at once to make use of them," and that he intends to take into account terms of at least one order beyond those included by Gauss. The form in which the requisite data are to be presented to him is a magnetic chart of the whole surface of the globe. Materials from scientific travellers of all nations, from our home magnetic observatories, from the magnetic observatories of St. Helena, the Cape, Van Diemen's Land, and Toronto, and from the scientific observatories of other countries have been brought together by Sabine. Silently, day after day, night after night, for a quarter of a century he has toiled with one constant assistant always by his side to reduce these observations and prepare for the great work. At this moment, while we are here assembled, I believe that, in their quiet summer retirement in Wales, Sir Edward and Lady Sabine are at work on the magnetic chart of the world. If two years of life and health are granted to them, science will be provided with a key which must powerfully conduce to the ultimate opening up of one of the most refractory enigmas of cosmical physics, the cause of terrestrial magnetism.

To give any sketch, however slight, of scientific investigation performed during the past year, would, even if I were competent for the task, far exceed the limits within which I am confined on the present occasion. A detailed account of work done and knowledge gained in science Britain ought to have every year. The *Journal of the Chemical Society* and the *Zoological Record* do excellent service by giving abstracts of all papers published in their departments. The admirable example afforded by the German "Fortschritte"

and "Jahresbericht" is before us; but hitherto, so far as I know, no attempt has been made to follow it in Britain. It is true that several of the annual volumes of the "Jahresbericht" were translated; but a translation, published necessarily at a considerable interval of time after the original, cannot supply the want. An independent British publication is for many obvious reasons desirable. The two publications, in German and English, would, both by their differences and by their agreements, illustrate the progress of science more correctly and usefully than any single work could do, even if appearing simultaneously in the two languages. It seems to me that to promote the establishment of a British Year Book of Science is an object to which the powerful action of the British Association would be thoroughly appropriate.

In referring to recent advances in several branches of science, I simply choose some of those which have struck me as most notable.

Accurate and minute measurement seems to the non-scientific imagination a less lofty and dignified work than looking for something new. But nearly all the grandest discoveries of science have been but the rewards of accurate measurement and patient long-continued labour in the minute sifting of numerical results. The popular idea of Newton's grandest discovery is that the theory of gravitation flashed into his mind, and so the discovery was made. It was by a long train of mathematical calculation, founded on results accumulated through prodigious toil of practical astronomers, that Newton first demonstrated the forces urging the planets towards the sun, determined the magnitudes of those forces, and discovered that a force following the same law of variation with distance urges the moon towards the earth. Then first, we may suppose, came to him the idea of the universality of gravitation; but when he attempted to compare the magnitude of the force on the moon with the magnitude of the force of gravitation of a heavy body of equal mass at the earth's surface, he did not find the agreement which the law he was discovering required. Not for years after would he publish his discovery as made. It is recounted that, being present at a meeting of the Royal Society, he heard a paper read, describing geodesic measurement by Picard which led to a serious correction of the previously accepted estimate of the earth's radius. This was what Newton required. He went home with the result, and commenced his calculations, but felt so much agitated that he handed over the arithmetical work to a friend: then (and not when, sitting in a garden, he saw an apple fall) did he ascertain that gravitation keeps the moon in her orbit.

Faraday's discovery of specific inductive capacity, which inaugurated the new philosophy, tending to discard action at a distance, was the result of minute and accurate measurement of electric forces.

Joule's discovery of thermo-dynamic laws through the regions of electro-chemistry, electro-magnetism, and elasticity of gases was based on a delicacy of thermometry which seemed simply impossible to some of the most distinguished chemists of the day.

Andrews's discovery of the continuity between the gaseous and liquid states was worked out by many years of laborious and minute measurement of phenomena scarcely sensible to the naked eye.

Great service has been done to science by the British Association in promoting accurate measurement in various subjects. The origin of exact science in terrestrial magnetism is traceable to Gauss's invention of methods of finding the magnetic intensity in absolute measure. I have spoken of the great work done by the British Association in carrying out the application of this invention in all parts of the world. Gauss's colleague, in the German Magnetic Union, Weber, extended the practice of absolute measurement to electric currents, the resistance of an electric conductor, and the electromotive force of a galvanic element. He showed the relation between electrostatic and electro-magnetic units for absolute measurement, and made the beautiful discovery that resistance, in absolute electro-magnetic measure, and the reciprocal of resistance, or, as we call it, "conducting power," in electrostatic measure, are each of them a velocity. He made an elaborate and difficult series of experiments to measure the velocity which is equal to the conducting power, in electrostatic measure, and at the same time to the resistance in electro-magnetic measure, in one and the same conductor. Maxwell, in making the first advance along a road of which Faraday was the pioneer, discovered that this velocity is physically related to the velocity of light, and that, on a certain hypothesis regarding the elastic medium concerned, it may be exactly equal to the velocity of light. Weber's measurement verifies approximately this equality, and stands in science *monumentum ære perennius*, celebrated as having suggested this most grand theory, and as having afforded the first quantitative test of the recondite properties of matter on which the relations between electricity and light depend. A remeasurement of Weber's critical velocity on a new plan by Maxwell himself, and the important correction of the velocity of light by Foucault's laboratory experiments, verified by astronomical observation, seem to show a still closer agreement. The most accurate possible determination of Weber's critical velocity is just now a primary object of the Association's Committee on Electric Measurement, and it is at present premature to speculate as to the closeness of the agreement between that velocity and the velocity of light. This leads me to remark how much science, even in its most lofty speculations, gains in return for benefits conferred by its application to promote the social and material welfare of man. Those who perilled and lost their money in the original Atlantic telegraph were impelled and supported by a sense of the grandeur of their enterprise, and of the world-wide benefits which must flow from its success; they were at the same time not unmoved by the beauty of the scientific problem directly presented to them; but they little thought that it was to be immediately, through their work, that the scientific world was to be instructed in a long-neglected and discredited fundamental electric discovery of Faraday's, or that, again, when the assistance of the British Association was invoked to supply their electricians with methods for absolute measurement (which they found necessary to secure the best economical return for their expenditure, and to obviate and detect those faults in their electric material which had led to disaster), they were laying the foundation for accurate electric measurement in every scientific laboratory in the world, and initiating a train of investigation which now sends up branches into the loftiest regions and subtlest other of natural philosophy. Long may the British Association continue a bond of union, and a medium for the interchange of good offices between science and the world.

The greatest achievement yet made in molecular theory of the properties of matter is the Kinetic theory of gases, shadowed forth by Lucretius, definitely stated by Daniel Bernoulli, largely developed by Herapath, made a reality by Joule, and worked out to its present advanced state by Clausius and Maxwell. Joule, from his dynamical equivalent of heat, and his experiments upon the heat produced by the condensation of gas, was able to estimate the average velocity of the ultimate molecules or atoms composing it. His estimate for hydrogen was 6225 ft. per second at temperature 60° Fahr., and 6055 ft. per second at the freezing point. Clausius took fully into account the impacts of molecules on one another, and the kinetic energy of relative motions of the matter constituting an individual atom. He investigated the relation between their diameters, the number in a given space, and the mean length of path from impact to impact, and so gave the foundation for estimates of the absolute dimensions of atoms, to which I shall refer later. He explained the slowness of gaseous diffusion by the mutual impacts of the atoms, and laid a secure foundation for a complete theory of the diffusion of fluids, previously a most refractory enigma. The deeply penetrating genius of Maxwell brought in viscosity and thermal conductivity, and thus completed the dynamical explanation of all the known properties of gases, except their electric resistance and brittleness to electric force.

No such comprehensive molecular theory had ever been even imagined before the nineteenth century. Definite and complete in its area as it is, it is but a well-drawn part of a great chart, in which all physical science will be represented with every property of matter shown in dynamical relation to the whole. The prospect we now have of an early completion of this chart is based on the assumption of atoms. But there can be no permanent satisfaction to the mind in explaining heat, light, elasticity, diffusion, electricity and magnetism, in gases, liquids, and solids, and describing precisely the relations of these different states of matter to one another by statistics of great numbers of atoms, when the properties of the atom itself are simply assumed. When the theory, of which we have the first instalments in Clausius and Maxwell's work, is complete, we are but brought face to face with a superlatively grand question, what is the inner mechanism of the atom?

In the answer to this question we must find the explanation not only of the atomic elasticity, by which the atom is a chronometric vibrator according to Stokes's discovery, but of chemical affinity and of the differences of quality of different chemical elements, at present a mere mystery in science. Helmholtz's exquisite theory of vortex-motion in an incompressible frictionless liquid has been suggested as a finger-post, pointing a way which may possibly lead to a full understanding of the properties of atoms, carrying out the grand conception of Lucretius, who "admits no subtile others, no variety of elements with fiery, or watery, or light, or heavy principles; nor supposes light to be one thing, fire another, electricity a fluid, magnetism a vital principle, but treats all phenomena as mere properties or accidents of simple matter." This statement I take from an admirable paper on the atomic theory of Lucretius, which appeared in the *North British Review*, for March, 1868, containing a most interesting and instructive summary of ancient and modern doctrine regarding atoms. Allow me to read from that article one other short passage finely describing the present aspect of atomic theory:—"The existence of the chemical atom, already quite a complex little world, seems very probable; and the description of the Lucretian atom is wonderfully applicable to it. We are not wholly without hope that the real weight of each such atom may some day be known—not merely the relative weight of the several atoms, but the number in a given volume of any material; that the form and motion of the parts of each atom and the distances by which they are separated may be calculated; that the motions by which they produce heat, electricity, and light may be illustrated by exact geometrical diagrams; and that the fundamental properties of the intermediate and possibly constituent medium may be arrived at. Then the motion of planets and music of the spheres will be neglected for a while in admiration of the maze in which the tiny atoms run."

Even before this was written some of the anticipated results had been partially attained. Loschmidt in Vienna had shown, and not much later Stoney independently in England showed, how to deduce from Clausius and Maxwell's kinetic theory of gases a superior limit to the number of atoms in a given measurable space. I was unfortunately quite unaware of what Loschmidt and Stoney had done when I made a similar estimate on the same foundation, and communicated it to *Nature* in an article on "The Size of Atoms." But questions of personal priority, however interesting they may be to the persons concerned, sink into insignificance in the prospect of any gain of deeper insight into the secrets of nature. The triple coincidence of independent reasoning to this case is valuable as confirmation of a conclusion violently contravening ideas and opinions which had been almost universally held regarding the dimensions of the molecular structure of matter. Chemists and other naturalists had been in the habit of evading questions as to the hardness or indivisibility of atoms by virtually assuming them to be infinitely small and infinitely numerous. We must now no longer look upon the atom, with Boscovich, as a mystic point endowed with inertia and the attribute of attracting or repelling other such centres with forces depending upon the intervening distances (a supposition only tolerated with the tacit assumption that the inertia and attraction of each atom is infinitely small and the number of atoms infinitely great), nor can we agree with those who have attributed to the atom occupation of space with infinite hardness and strength (incredible in any finite body); but we must realise it as a piece of matter of measurable dimensions, with shape, motion, and laws of action, intelligible subjects of scientific investigation.

The prismatic analysis of light discovered by Newton was estimated by himself as being "the oddest, if not the most considerable, detection which hath hitherto been made in the operations of nature."

Had he not been deflected from the subject, he could not have failed to obtain a pure spectrum; but this, with the inevitably consequent discovery of the dark lines, was reserved for the nineteenth century. Our fundamental knowledge of the dark lines is due solely to Fraunhofer. Wollaston saw them, but did not discover them. Brewster laboured long and well to perfect the prismatic analysis of sunlight; and his observations on the dark bands produced by the absorption of interposed gases and vapours laid important foundations for the grand superstructure which he scarcely lived to see. Piazzi Smyth, by spectroscopic observation performed on the Peak of Teneriffe, added greatly to our knowledge of the dark lines produced in the solar spectrum by the absorption of our own atmosphere. The prism became an instrument for chemical qualitative analysis in the hands of Fox, Talbot, and Herschel, who first showed how, through it, the old "blowpipe test" or generally the estimation of substances from the colours which they give to flames, can be prosecuted with an accuracy and a discriminating power not to be attained when the colour is judged by the unaided eye. But the application of this test to solar and stellar chemistry had never, I believe, been suggested, either directly or indirectly, by any other naturalist, when Stokes taught it to me in Cambridge at some time prior to the summer of 1852. The observational and experimental foundations on which he built were:

1. The discovery by Fraunhofer of a coincidence between his double dark line, D, of the solar spectrum and a double bright line which he observed in the spectra of ordinary artificial flames.

2. A very rigorous experimental test of this coincidence by Professor W. H. Miller, which showed it to be accurate to an astonishing degree of minuteness.

3. The fact that the yellow light given out when salt is thrown on burning spirit consists almost solely of the two nearly identical qualities which constitute that double bright line.

4. Observations made by Stokes himself, which showed the bright line, D, to be absent in a candle-flame when the wick was snuffed clean, so as not to project into the luminous envelope, and from an alcohol flame when the spirit was burned in a watch-glass. And

5. Foucault's admirable discovery (L'Institute, Feb. 7, 1849) that the voltaic arc between charcoal points is "a medium which emits the rays, D, on its own account, and at the same time absorbs them when they come from another quarter."

The conclusions, theoretical and practical, which Stokes taught me, and which I gave regularly afterwards in my public lectures in the University of Glasgow, were:

1. That the double line D, whether bright or dark, is due to vapour of sodium.

2. That the ultimate atom of sodium is susceptible of regular elastic vibrations, like those of a tuning-fork or of stringed musical instruments; that like an instrument with two strings tuned to approximate unison, or an approximately circular elastic disc, it has two fundamental notes or vibrations of approximately equal pitch; and that the periods of these vibrations are precisely the periods of the two slightly different yellow lights constituting the double bright line D.

3. That when vapour of sodium is at a high enough temperature to become itself a source of light, each atom executes these two fundamental vibrations simultaneously; and that, therefore, the light proceeding from it is of the two qualities constituting the double bright line D.

4. That when vapour of sodium is present in space across which light from another source is propagated, its atoms, according to a well-known general principle of dynamics, are set to vibrate in either or both of those fundamental modes, if some of the incident light is of one or other of their periods, or some of one and some of the other; so that the energy of the waves of those particular qualities of light is converted into thermal vibrations of the medium and dispersed in all directions, while light of all other qualities, even though very nearly agreeing with them, is transmitted with comparatively no loss.

5. That Fraunhofer's double dark line D of solar and stellar spectra is due to the presence of vapour of sodium in atmospheres surrounding the sun and those stars in whose spectra it had been observed.

6. That other vapours than sodium are to be found in the atmospheres of sun and stars by searching for substances producing in the spectra of artificial flames bright lines coinciding with other dark lines of the solar and stellar spectra than the Fraunhofer line D.

The last of these propositions I felt to be confirmed (it was perhaps partly suggested) by a striking and beautiful experiment admirably adapted for lecture illustrations, due to Foucault, which had been shown to me by M. Duboscque Soleir, and the Abbé Moigno, in Paris in the month of October, 1850. A prism and lenses were arranged to throw upon a screen an approximately pure spectrum of a vertical electric arc between charcoal poles of a powerful battery, the lower one of which was hollowed like a cup. When pieces of copper and pieces of zinc were separately thrown into the cup, the spectrum exhibited, in perfectly definite positions, magnificent well marked bands of different colours characteristic of the two metals. When a piece of brass,

compounded of copper and zinc, was put into the cup, the spectrum showed all the bands, each precisely in the place in which it had been seen when one metal or the other had been used separately.

It is much to be regretted that this great generalisation was not published to the world twenty years ago. I say this, not because it is to be regretted that Angström should have the credit of having in 1853 published independently the statement that "an incandescent gas emits luminous rays of the same refrangibility as those which it can absorb;" or that Balfour Stewart should have been unassisted by it when, coming to the subject from a very different point of view, he made, in his extension of the "Theory of Exchanges,"* the still wider generalisation that the radiating power of every kind of substance is equal to its absorbing power for every kind of ray; or that Kirchhoff also should have in 1859 independently discovered the same proposition, and shown its application to solar and stellar chemistry; but because we might now be in possession of the inconceivable riches of astronomical results which we expect from the next ten years' investigation by spectrum analysis, had Stokes given his theory to the world when it first occurred to him.

To Kirchhoff belongs, I believe, solely the great credit of having first actually sought for and found other metals than sodium in the sun by the method of spectrum analysis. His publication of October, 1859, inaugurated the practice of solar and stellar chemistry, and gave spectrum analysis an impulse to which in a great measure is due its splendidly successful cultivation by the labours of many able investigators within the last ten years.

To the prodigious and wearing toil of Kirchhoff himself, and of Angström, we owe large-scale maps of the solar spectrum, incomparably superior in minuteness and accuracy of delineation to anything ever attempted previously. These maps now constitute the standards of reference for all workers in the field. Plücker and Hittorf opened ground in advancing the physics of spectrum analysis and made the important discovery of changes in the spectra of ignited gases produced by changes in the physical condition of the gas. The scientific value of the meetings of the British Association is well illustrated by the fact that it was through conversation with Plücker at the Newcastle meeting that Lockyer was first led into the investigation of the effects of varied pressure on the quality of the light emitted by glowing gas which he and Frankland have prosecuted with such admirable success. Scientific wealth tends to accumulation according to the law of compound interest. Every addition to knowledge of properties of matter supplies the naturalist with new instrumental means for discovering and interpreting phenomena of nature, which in their turn afford foundations for fresh generalisations, bringing gains of permanent value into the great storehouse of philosophy. Thus Frankland, led, from observing the want of brightness of a candle burning in a tent on the summit of Mont Blanc, to scrutinise Davy's theory of flame, discovered that brightness without incandescent solid particles is given to a purely gaseous flame by augmented pressure, and that a dense ignited gas gives a spectrum comparable with that of the light from an incandescent solid or liquid. Lockyer joined him; and the two found that every incandescent substance gives a continuous spectrum—that an incandescent gas under varied pressure gives bright bars across the continuous spectrum, some of which, from the sharp, hard and fast lines observed where the gas is in a state of extreme attenuation, broaden out on each side into nebulous bands as the density is increased, and are ultimately lost in the continuous spectrum when the condensation is pushed on till the gas becomes a fluid no longer to be called gaseous. More recently they have examined the influence of temperature, and have obtained results which seem to show that a highly attenuated gas, which at a high temperature gives several bright lines, gives a smaller and smaller number of lines, of sufficient brightness to be visible, when the temperature is lowered, the density being kept unchanged. I cannot refrain here from remarking how admirable this beautiful investigation harmonises with Andrews's great discovery of continuity between the gaseous and liquid states. Such things make the life-blood of science. In contemplating them we feel as if led out from narrow waters of scholastic dogma to a refreshing excursion on the broad and deep ocean of truth, where we learn from the wonders we see that there are endlessly more and more glorious wonders still unseen.

Stokes's dynamical theory supplies the key to the philosophy of Frankland and Lockyer's discovery. Any atom of gas when struck and left to itself vibrates with perfect purity its fundamental note or notes. In a highly attenuated gas each atom is very rarely in collision with other atoms, and therefore is nearly at all times in a state of true vibration. Hence the spectrum of a highly attenuated gas consists of one or more perfectly sharp bright lines, with a scarcely perceptible continuous gradation of prismatic colour. In denser gas each atom is frequently in collision, but still is for much more time free, in intervals between collisions, than engaged in collision; so that not only is the atom itself thrown sensibly out of tune during a sensible proportion of its whole time, but the confused jangle of vibrations in every variety of period during the actual collision becomes more considerable in its influence. Hence bright lines in the spectrum broaden out somewhat, and the continuous spectrum becomes less faint. In still denser gas each atom may be almost as much time in collision as free, and the spectrum then consists of broad nebulous bands crossing a continuous spectrum of considerable brightness. When the medium is so dense that each atom is always in collision, that is to say, never free from influence of its neighbours, the spectrum will generally be continuous, and may present little or no appearance of bands, or even of maxima of brightness. In this condition the fluid can be no longer regarded as a gas, and we must judge of its relation to the vaporous or liquid states according to the critical conditions discovered by Andrews.

* Edinburgh Transactions, 1858-59.

While these great investigations of properties of matter were going on, naturalists were not idle with the newly recognised power of the spectroscope at their service. Chemists soon followed the example of Bunsen in discovering new metals in terrestrial matter by the old blow-pipe and prism test of Fox Talbot and Herschel. Biologists applied spectrum analysis to animal and vegetable chemistry, and to sanitary investigations. But it is in astronomy that spectroscopic research has been carried on with the greatest activity, and been most richly rewarded with results. The chemist and the astronomer have joined their forces. An astronomical observatory has now, appended to it, a stock of reagents such as hitherto was only to be found in the chemical laboratory. A devoted corps of volunteers of all nations, whose motto might well be ubique, have directed their artillery to every region of the universe. The sun, the spots on his surface, the corona and the red and yellow prominences seen round him during total eclipses, the moon, the planets, comets, auroras, nebulæ, white stars, yellow stars, red stars, variable and temporary stars, each tested by the prism was compelled to show its distinguishing prismatic colours. Rarely before in the history of science has enthusiastic perseverance directed by penetrative genius produced within ten years so brilliant a succession of discoveries. It is not merely the chemistry of sun and stars, as first suggested, that is subjected to analysis by the spectroscope. Their whole laws of being are now subjects of direct investigation; and already we have glimpses of their evolutional history through the stupendous power of this most subtle and delicate test. We had only solar and stellar chemistry; we now have solar and stellar physiology.

It is an old idea that the colour of the star may be influenced by its motion relatively to the eye of the spectator, so as to be tinged with red if it moves from the earth, or blue if it moves towards the earth. William Allen Miller, Huggins, and Maxwell showed how, by aid of the spectroscope, this idea may be made the foundation of a method of measuring the relative velocity with which a star approaches to or recedes from the earth. The principle is, first to identify, if possible, one or more of the lines in the spectrum of the star, with a line or lines in the spectrum of sodium, or some other terrestrial substance, and then (by observing the star and the artificial light simultaneously by the same spectroscope) to find the difference, if any, between their refrangibilities. From this difference of refrangibility the ratio of the periods of the two lights is calculated, according to data determined by Fraunhofer from comparisons between the positions of the dark lines in the prismatic spectrum, and in his own "interference spectrum" (produced by substituting for the prism a fine grating). A first comparatively rough application of the test by Miller and Huggins to a large number of the principal stars of our skies, including Aldebaran, α Orionis, β Pegasi, Sirius, α Lyræ, Capella, Arcturus, Pollux, Castor (which they had observed rather for the chemical purpose than for this), proved that not one of them had so great a velocity as 315 kilometres per second to or from the earth, which is a most momentous result in respect to cosmical dynamics. Afterwards Huggins made special observations of the velocity test, and succeeded in making the measurement in one case, that of Sirius, which he then found to be receding from the earth at the rate of 66 kilometres per second. This, corrected for the velocity of the earth at the time of the observation, gave a velocity of Sirius, relatively to the sun, amounting to 47 kilometres per second. The minuteness of the difference to be measured, and the smallness of the amount of light, even when the brightest star is observed, renders the observation extremely difficult. Still, with such great skill as Mr. Huggins has brought to bear on the investigation, it can scarcely be doubted that velocities of many other stars may be measured. What is now wanted is, certainly not greater skill, perhaps not even more powerful instruments, but more instruments and more observers. Lockyer's applications of the velocity test to the relative motions of different gases in the sun's photosphere, spots, chromosphere, and chromospheric prominences, and his observations of the varying spectra presented by the same substance as it moves from one position to another in the sun's atmosphere, and his interpretations of these observations, according to the laboratory results of Frankland and himself, go far towards confirming the conviction that in a few years all the marvels of the sun will be dynamically explained according to known properties of matter.

During six or eight precious minutes of time, spectroscopes have been applied to the solar atmosphere and to the corona seen round the dark disc of the moon eclipsing the sun. Some of the wonderful results of such observations, made in India on the occasion of the eclipse of August, 1868, were described by Professor Stokes in a previous address. Valuable results have, through the liberal assistance given by the British and American Governments, been obtained also from the total eclipse of last December, notwithstanding a generally unfavourable condition of weather. It seems to have been proved that at least some sensible part of the light of the "corona" is a terrestial atmospheric halo or dispersive reflection of the light of the glowing hydrogen and "helium"* round the sun. I believe I may say, on the present occasion when preparation must again be made to utilise a total eclipse of the sun, that the British Association confidently trusts to our Government exercising the same wise liberality as heretofore in the interests of science.

The old nebular hypothesis supposes the solar system and other similar systems through the universe which we see at a distance as stars, to have originated in the condensation of fiery nebulous matter. This hypothesis was invented before the discovery of thermo-dynamics, or the nebulæ would not have been supposed to be fiery; and the idea seems never to have occurred to any of its inventors or early supporters that the matter, the condensation of which they supposed to constitute the sun and stars, could have been other than fiery in the beginning. Mayer first suggested that the heat of the sun may be due to gravitation: but he supposed meteors falling in to keep always generating the heat which is radiated year by year from the sun. Helmholtz, on the other hand, adopting the nebular hypothesis, showed in 1854 that it was not necessary to suppose the nebulous matter to have been originally fiery, but that mutual gravitation between its parts may have generated the heat to which the present high temperature of the sun is due. Further he made the important observations that the potential energy of gravitation in the sun is even now far from exhausted; but that with further and further shrinking more and more heat is to be generated, and that thus we can conceive the sun even now to possess a sufficient store of energy to produce heat and light, almost as at present, for several million years of time future. It ought, however, to be added that this condensation can only follow from cooling, and therefore that Helmholtz's gravitational explanation of future sun heat amounts really to showing that the sun's thermal capacity is enormously greater, in virtue of the mutual gravitation between the parts of so enormous a mass, than the sum of the thermal capacities of separate and smaller bodies of the same material and same total mass. Reasons for adopting this theory, and the consequences which follow from it, are discussed in an article "On the Age of the Sun's Heat," published in *Macmillan's Magazine* for March, 1862.

For a few years Mayer's theory of solar heat had seemed to me probable; but I had been led to regard it as no longer tenable, because I had been in the first place driven, by consideration of the very approximate constancy of the earth's period of revolution round the sun for the last 2000 years, to conclude that "The principal source, perhaps the sole appreciably effective source of sun-heat, is in bodies circulating round the sun at present inside the earth's orbit;"* and because Leverrier's researches on the motion of the planet Mercury, though giving evidence of a sensible influence attributable to matter circulating as a great number of small planets within his orbit round the sun, showed that the amount of matter that could possibly be assumed to circulate at any considerable distance from the sun must be very small; and therefore "if the meteoric influx taking place at present is enough to produce any appreciable portion of the heat radiated away, it must be supposed to be from matter circulating round the sun, within very short distances of his surface. The density of this meteoric cloud would have to be supposed so great that comets could scarcely have escaped as comets actually have escaped, showing no discoverable effects of resistance, after passing his surface within a distance equal to one-eighth of his radius. All things considered, there seems little probability in the hypothesis that solar radiation is compensated to any appreciable degree, by heat generated by meteors falling in, at present; and, as it can be shown that no chemical theory is tenable,† it must be concluded as most probable that the sun is at present merely an incandescent liquid mass cooling."‡

Thus on purely astronomical grounds was I long ago led to abandon as very improbable the hypothesis that the sun's heat is supplied dynamically from year to year by the influx of meteors. But now spectrum analysis gives proof finally conclusive against it.

Each meteor circulating round the sun must fall in along a very gradual spiral path, and before reaching the sun must have been for a long time exposed to an enormous heating effect from his radiation when very near, and must thus have been driven into vapour before actually falling into the sun. Thus, if Mayer's hypothesis is correct, friction between vortices of meteoric vapours and the sun's atmosphere must be the immediate cause of solar heat; and the velocity with which these vapours circulate round equatorial parts of the sun must amount to 435 kilometres per second. The spectrum test of velocity applied by Lockyer showed but a twentieth part of this amount as the greatest observed relative velocity between different vapours in the sun's atmosphere.

At the first Liverpool meeting of the British Association (1854), in advancing a gravitational theory to account for all the heat, light, and motions of the universe, I urged that the immediately antecedent condition of the matter of which the sun and planets were formed, not being fiery, could not have been gaseous; but that it probably was solid, and may have been like the meteoric stones which we still so frequently meet with through space. The discovery of Huggins, that the light of the nebulæ, so far as hitherto sensible to us, proceeds from incandescent hydrogen and nitrogen gases, and that the heads of comets also give us light of incandescent gas, seems at first sight literally to fulfil that part of the nebular hypothesis to which I had objected. But a solution, which seems to me in the highest degree probable, has been suggested by Tait. He supposes that it may be by ignited gaseous exhalations proceeding from the collision of meteoric stones that nebulæ and the heads of comets show themselves to us, and he suggested, at a former meeting of the Association, that experiments should be made for the purpose of applying spectrum analysis to the light which has been observed in gunnery trials, such as those at Shoeburyness, when iron strikes against iron at a great velocity, but varied by substituting for the iron various solid materials, metallic or stony. Hitherto this suggestion has not been acted upon; but surely it is one the carrying out of which ought to be promoted by the British Association.

Most important steps have been recently made towards the discovery of the nature of comets; establishing with

* Frankland and Lockyer find the yellow prominences to give a very decided bright line not far from D, but hitherto not identified with any terrestrial flame. It seems to indicate a new substance, which they propose to call helium.

* "On the mechanical energies of the Solar System." Transactions of the Royal Society of Edinburgh, 1854; and Phil. Mag. 1854, second half year.

† "Mechanical Energies," &c.

‡ "Age of the Sun's Heat" (*Macmillan's Magazine*, March, 1862).

nothing short of certainty the truth of a hypothesis which had long appeared to me probable, that they consist of groups of meteoric stones; accounting satisfactorily for the light of the nucleus; and giving a simple and rational explanation of phenomena presented by the tails of comets which had been regarded by the greatest astronomers as almost preternaturally marvellous. The meteoric hypothesis to which I have referred remained a mere hypothesis (I do not know that it is was ever even published), until, in 1866, Schiaparelli calculated, from observations on the August meteors, an orbit for these bodies which he found to agree almost perfectly with the orbit of the great comet of 1862, as calculated by Oppolzer; and so discovered and demonstrated that a comet consists of a group of meteoric stones. Professor Newton, of Yale College, United States, by examining ancient records, ascertained that in periods of about 33 years, since the year 902, there have been exceptionally brilliant displays of the November meteors. It had long been believed that these interesting visitants came from a train of small detached planets circulating round the sun all in nearly the same orbit, and constituting a belt analogous to Saturn's ring, and that the reason for the comparatively large number of meteors which we observe annually about the 14th of November is, that at that time the earth's orbit cuts through the supposed meteoric belt. Professor Newton concluded from his investigation that there is a denser part of the group of meteors which extends over a portion of the orbit so great as to occupy about one-tenth or one-fifteenth of the periodic time in passing any particular point, and gave a choice of five different periods for the revolution of this meteoric stream round the sun, any one of which would satisfy his statistical result. He further concluded that the line of nodes, that is to say, the line in which the plan of the meteoric belt cuts the plane of the earth's orbit, has a progressive sidereal motion of about 52″.4 per annum. Here, then, was a splendid problem for the physical astronomer; and happily, one well qualified for the task, took it up. Adams, by the application of a beautiful method invented by Gauss, found that of the five periods allowed by Newton just one permitted the motion of the line of nodes to be explained by the disturbing influence of Jupiter, Saturn, and other planets. The period chosen on these grounds is 33¼ years. The investigation showed further that the form of the orbit is a long ellipse, giving for shortest distance from the sun 145 million kilometres, and for longest distance 2895 million kilometres. Adams also worked out the longitude of the perihelion and the inclination of the orbit's plane to the plane of the ecliptic. The orbit which he thus found agreed so closely with that of Tempel's Comet I. 1866, that he was able to identify the comet and the meteoric belt.* The same conclusion had been pointed out a few weeks earlier by Schiaparelli, from calculations by himself on data supplied by direct observations on the meteors, and independently by Peters from calculations by Leverrier on the same foundation. It is therefore thoroughly established that Tempel's Comet I. 1866, consists of an elliptic train of minute planets, of which a few thousands of millions fall to the earth annually about the 14th of November, when we cross their track. We have probably not yet passed through the very nucleus or densest part; but thirteen times, in Octobers and Novembers, from October 13, A.D. 902 to November 14, 1866 inclusive (this last time having been correctly predicted by Professor Newton), we have passed through a part of the belt greatly denser than the average. The densest part of the train, when near enough to us, is visible as the head of the comet. This astounding result, taken along with Huggins's spectroscopic observations on the light of the heads and tails of comets, confirm most strikingly Tait's theory of comets, to which I have already referred; according to which the comet, a group of meteoric stones, is self-luminous in its nucleus on account of collisions among its constituents, while its "tail" is merely a portion of the less dense part of the train illuminated by sunlight, and visible or invisible to us according to circumstances, not only of density, degree of illumination, and nearness, but also of tactic arrangement, as of a flock of birds or the edge of a cloud of tobacco smoke! What prodigious difficulties are to be explained, you may judge from two or three sentences which I shall read from Herschel's Astronomy, and from the fact that even Schiaparelli seems still to believe in the repulsion. "There is, beyond question, some profound secret and mystery of nature concerned in the phenomenon of their tails. Perhaps it is not too much to hope that future observation, borrowing every aid from rational speculation, grounded on the progress of physical science generally (especially those branches of it which relate to the ethereal or imponderable elements), may enable us ere long to penetrate this mystery, and to declare whether it is really matter in the ordinary acceptation of the term which is projected from their heads with such extraordinary velocity, and if not impelled, at least directed, in its course, by reference to the sun, as its point of avoidance."†

"In no respect is the question as to the materiality of the tail more forcibly pressed on us for consideration than in that of the enormous sweep which it makes round the sun in perihelio in the manner of a straight and rigid rod in defiance of the law of gravitation, nay, even, of the received laws of motion."*

"The projection of this ray . . . to so enormous a length, in a single day conveys an impression of the intensity of the forces acting to produce such a velocity of material transfer through space, such as no other natural phenomenon is capable of exciting. It is clear that if we have to deal here with matter, such as we conceive it, viz., possessing inertia—at all, it must be under the dominion of forces incomparably more energetic than gravitation, and quite of a different nature"†.

Think now of the admirable simplicity with which Tait's beautiful "seabird analogy," as it has been called, can explain all these phenomena.

The essence of science, as is well illustrated by astronomy and cosmical physics, consists in inferring antecedent, conditions, and anticipating future evolutions, from phenomena which have actually come under observation. In biology the difficulties of successfully acting up to this ideal are prodigious. The earnest naturalists of the present day are, however, not appalled or paralysed by them, and are struggling boldly and laboriously to pass out of the mere "Natural History stage" of their study, and bring zoology within the range of Natural Philosophy. A very ancient speculation, still clung to by many naturalists (so much so that I have a choice of modern terms to quote in expressing it) supposes that, under meteorological conditions very different from the present, dead matter may have run together or crystallised or fermented into "germs of life," or "organic cells," or "protoplasm." But science brings a vast mass of inductive evidence against this hypothesis of spontaneous generation, as you have heard from my predecessor in the presidential chair. Careful enough scrutiny has, in every case up to the present day, discovered life as antecedent to life. Dead matter cannot become living without coming under the influence of matter previously alive. This seems to me as sure a teaching of science as the law of gravitation. I utterly repudiate, as opposed to all philosophical uniformitarianism, the assumption of "different meteorological conditions"—that is to say, somewhat different vicissitudes of temperature, pressure, moisture, gaseous atmosphere—to produce or to permit that to take place by force or motion of dead matter alone, which is a direct contravention of what seems to us biological law. I am prepared for the answer, "our code of biological law is an expression of our ignorance as well as of our knowledge." And I say yes: search for spontaneous generation out of inorganic materials; let any one not satisfied with the purely negative testimony of which we have now so much against it, throw himself into the inquiry. Such investigations as those of Pasteur, Pouchet, and Bastian are among the most interesting and momentous in the whole range of Natural History, and their results, whether positive or negative, must richly reward the most careful and laborious experimenting. I confess to being deeply impressed by the evidence put before us by Professor Huxley, and I am ready to adopt, as an article of scientific faith, true through all space and through all time, that life proceeds from life, and from nothing but life.

How, then, did life originate on the earth? Tracing the physical history of the earth backwards, on strict dynamical principles, we are brought to a red-hot melted globe on which no life could exist. Hence when the earth was first fit for life, there was no living thing on it. There were rocks solid and disintegrated, water, air all round, warmed and illuminated by a brilliant sun, ready to become a garden. Did grass and trees and flowers spring into existence, in all the fulness of ripe beauty, by a fiat of Creative Power? or did vegetation, growing up from seed sown, spread and multiply over the whole earth? Science is bound, by the everlasting law of honour, to face fearlessly every problem which can fairly be presented to it. If a probable solution, consistent with the ordinary course of nature, can be found, we must not invoke an abnormal act of Creative Power. When a lava stream flows down the sides of Vesuvius or Etna it quickly cools and becomes solid; and after a few weeks or years it teems with vegetable and animal life, which for it originated by the transport of seed and ova and by the migration of individual living creatures. When a volcanic island springs up from the sea, and after a few years is found clothed with vegetation, we do not hesitate to assume that seed has been wafted to it through the air, or floated to it on rafts. Is it not possible, and if possible, is it not probable, that the beginning of vegetable life on the earth is to be similarly explained? Every year thousands, probably millions, of fragments of solid matter fall upon the earth—whence came these fragments? What is the previous history of any one of them? Was it created in the beginning of time an amorphous mass? This idea is so unacceptable that, tacitly or explicitly, all men discard it. It is often assumed that all, and it is certain that some, meteoric stones are fragments which had been broken off from greater masses and launched free into space. It is as sure that collisions must occur between great masses moving through space as it is that ships, steered without intelligence directed to prevent collision, could not cross and recross the Atlantic for thousands of years with immunity from collisions. When two great masses come in collision in space it is certain that a large part of each is melted; but it seems also quite certain that in many cases a large quantity of débris must be shot forth in all directions, much of which may have experienced no greater violence than individual pieces of rock experience in a land-slip or in blasting by gunpowder. Should the time when this earth comes into collision with another body, comparable in dimensions to itself, be when it is still clothed as at present with vegetation, many great and small fragments carrying seed and living plants and animals would undoubtedly be scattered through space. Hence and because we all confidently believe that there are at present, and have been from time immemorial, many worlds of life besides our own, we must regard it as probable in the highest degree that there are countless seed-bearing meteoric stones moving about through space. If at the present instant no life existed upon this earth, one such stone falling upon it might, by what we blindly call natural causes, lead to its becoming covered with vegetation. I am fully conscious of the many scientific objections which may be urged against this hypothesis, but I believe them to be all answerable. I have already taxed your patience too severely to allow me to think of discussing any of them on the present occasion. The hypothesis that life originated on this earth through moss-grown fragments from the ruins of another world may seem wild and visionary; all I maintain is that it is not unscientific.

From the earth stocked with such vegetation as it could receive meteorically, to the earth teeming with all the endless variety of plants and animals which now inhabit it, the step is prodigious; yet, according to the doctrine of continuity, most ably laid before the Association by a predecessor in this chair (Mr. Grove), all creatures now living on earth have proceeded by orderly evolution from some such origin. Darwin concludes his great work on "The Origin of Species" with the following words:—"It is interesting to contemplate an entangled bank clothed with many plants of many kinds, with birds singing on the bushes, with various insects flitting about, and with worms crawling through the damp earth, and to reflect that these elaborately constructed forms, so different from each other, and dependent on each other in so complex a manner, have all been produced by laws acting around us." . . . . "There is grandeur in this view of life with its several powers, having been originally breathed by the Creator into a few forms or into one; and that, whilst this planet has gone cycling on according to the fixed law of gravity, from so simple a beginning endless forms, most beautiful and most wonderful, have been and are being evolved." With the feeling expressed in these two sentences I most cordially sympathise. I have omitted two sentences which come between them, describing briefly the hypothesis of "the origin of species by natural selection," because I have always felt that this hypothesis does not contain the true theory of evolution, if evolution there has been, in biology. Sir John Herschel, in expressing a favourable judgment on the hypothesis of zoological evolution, with, however, some reservation in respect to the origin of man, objected to the doctrine of natural selection, that it was too like the Laputan method of making books, and that it did not sufficiently take into account a continually guiding and controlling intelligence. This seems to me a most valuable and instructive criticism. I feel profoundly convinced that the argument of design has been greatly too much lost sight of in recent zoological speculations. Reaction against the frivolities of teleology, such as are to be found, not rarely, in the notes of the learned Commentators on Paley's "Natural Theology," has I believe had a temporary effect in turning attention from the solid and irrefragable argument so well put forward in that excellent old book. But overpoweringly strong proofs of intelligent and benevolent design lie all round us, and if ever perplexities, whether metaphysical or scientific, turn us away from them for a time, they come back upon us with irresistible force, showing to us through nature the influence of a free will, and teaching us that all living beings depend on one ever-acting Creator and Ruler.

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* Signor Schiaparelli, Director of the Observatory of Milan, who, in a letter dated 31st December, 1866, pointed out that the elements of the orbit of the August meteors, calculated from the observed position of their radiant point on the supposition of the orbit being a very elongated ellipse agreed very closely with those of the orbit of Comet II., 1862, calculated by Dr. Oppolzer. In the same letter Schiaparelli gives elements of the orbit of the November meteors, but these were not sufficiently accurate to enable him to identify the orbit with that of any known comet. On the 21st January, 1867, M. Leverrier gave more accurate elements of the orbit of the November meteors, and in the Astronomische Nachrichten of January 9, Mr. C. F. W. Peters, of Altona, pointed out that these elements closely agreed with those of Tempel's Comet (I. 1866), calculated by Dr. Oppolzer, and on February 2, Schiaparelli having recalculated the elements of the orbit of the meteors, himself noticed the same agreement. Adams arrived quite independently at the conclusion that the orbit of 33¼ years period, is the one which must be chosen, out of the five indicated by Professor Newton. His calculations were sufficiently advanced before the letters referred to appeared, to show that the other four orbits offered by Newton were inadmissible. But the calculations to be gone through to find the secular motion of the node in such an elongated orbit as that of the meteors, were necessarily very long, so that they were not completed till about March, 1867. They were communicated in that month to the Cambridge Philosophical Society, and in the month following to the Astronomical Society.

* Herschel's Astronomy, § 599.
† Herschel's Astronomy, 10th Edition, § 589.

LEAD DISCOVERIES.—Rich argentiferous lead is stated to have been discovered at Aspen, on the Union Pacific Railroad. Claims have been taken, and a company with a capital of 75,000 dols. has been formed to work them.

THE RUSSIAN NAVY.—The commandant of the port of Nicolaieff, Vice-Admiral Arkass, is making himself fully acquainted with every detail of the port. The Russian authorities are also credited with an intention to make a geographical or rather a hydrographical survey of the Black Sea and the Sea of Azoff, including the soundings, the temperature of the water, the best anchorages, &c.

A PROFITABLE LOCOMOTIVE.—Mr. A. J. Cassatt, the general superintendent of the Pennsylvania Railroad, has reported upon engine No. 422, which has been taken into shop for repairs, that she was placed upon the road October 17, 1867, and ran until May 17, 1871. During the whole of this time she hauled fast and heavy trains over the middle division, and she ran 153,280 miles, her repairs costing a little less than 2½ cents per mile.

ENORMOUS FALL OF GRANITE AT THE MOUNTSORRELL QUARRIES.—On the 7th instant a large blast of gunpowder was fired at these well-known quarries, attended with very remarkable results. The cliff, which may be seen from the Midland Railway between Barrow and Leicester, standing boldly up 100 ft. in height, and many hundreds of yards in length, was pierced about 40 ft. from the ground by a deep bore hole, and 450 lb. of powder secured therein. When the blast was fired the whole face of the rock came away together with scarcely any other sound than the crushing of the rock in its fall. The quantity thrown down is estimated at 20,000 tons, and is by far the largest weight of stone ever before moved by one blast at these granite quarries.

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LITERATURE.

A Complete Treatise on Cast and Wrought-Iron Bridge Construction, including Iron Foundations. In Three Parts: Theoretical, Practical, and Descriptive. Illustrated by numerous examples drawn to a large scale. By WILLIAM HUMBER, Assoc. Inst. C.E., Mem. Inst. M.E., &c. Third Edition, carefully revised, and considerably enlarged. London: Lockwood and Co.

[SECOND NOTICE.]

IN our first notice of Mr. Humber's book (*vide* page 363 of our last volume), we confined our remarks solely to the first, or theoretical, portion of the work, and we now propose to speak of the second, or practical portion. The first chapter in this second part, Chapter XI., is devoted to explaining the practical application of the formulæ given on the previous pages, and the explanations which it contains are for the most part clear and explicit; but we notice that in some cases sufficient care has not been taken to direct attention to points of detail on which the success or non-success of a structure so greatly depends. An instance of this kind is to be found on the second page of the chapter, where our author gives an example intended to illustrate the mode of calculating the proportions of the chains of a suspension bridge. The strain at the centre of the chains is assumed as 1000 tons, and the working strain being taken as 5 tons per square inch, a sectional area of 100 square inches is obtained for each chain. This section, it is further assumed, shall be made up by employing ten links, each 10 in. by 1 in., alternated with nine links, each measuring 10 in. by 1¼ in., and having got so far, Mr. Humber next proceeds to calculate the dimensions of the coupling joints. In doing this, however, he falls into a very serious error. Taking the working strain under shearing as 4 tons per square inch, he merely employs a formula which gives him 125 square inches of sheared area to resist the 500 tons strain, supposing the pins to be each sheared in eighteen places, and he thus obtains for the pins a diameter of a little less than 3 in. But it has long been well known that the proportions of the pins used for the chains of suspension bridges, and in similar situations, have not to be determined merely by calculating the sectional area required to resist shearing; but that they have to be made of such a diameter as to give sufficient bearing surface against the interiors of the holes in the links. As a matter of fact the pins for connecting such links as Mr. Humber has supposed to be employed in his example, should, in order that the joints might be equal in strength to the bodies of the links, be at least 6½ in. in diameter, and not 3 in., as he states. More than six-and-twenty years ago Sir Charles Fox, in experimenting on the proportions of the chains for the celebrated Kieff bridge, showed that the pins for connecting the links of suspension bridge chains should have a diameter equal to quite two-thirds the width of the links; some years later Mr. Brunel, in designing links for the Saltash and Chepstow bridges, came to a similar conclusion; while still more recently Mr. George Berkley, from some experiments carried out by him on the parts of some Warren girders, was led to adopt a proportion of three-fourths of the width of the link for the diameter of the pin. Of the form of the shoulder connecting the enlarged heads of the links with the main body, Mr. Humber says nothing; but he states that the head should be wider than the body of the link by the amount of the diameter of the pin, and he calculates the necessary overlap of the links as 6.25 in., thus giving but 1½ in. of metal outside the pinholes. Now the experiments to which we have already referred have shown that the aggregate section of the two sides of the eye should be, according to Mr. Brunel, 21 per cent., and according to Mr. Berkley 25 per cent. greater than the section of the body of the link, while Mr. Brunel found it necessary to make the thickness of metal outside the hole equal to 60 per cent. of the width of the link, and Mr. Berkley used a thickness equal to that width. The following short Table will show the difference between the proportions of the chain joints calculated by Mr. Humber, and those shown to be necessary by the experiments of Mr. Brunel, Sir Charles Fox, and Mr. Berkley.

	Dimensions calculated by	Dimensions shown to be necessary by the experiments of—		
	Mr. Humber.	Sir C. Fox.	Mr. Brunel.	Mr. Berkley.
	in.	in.	in.	in.
Diameter of pin	3	6⅔	6¾	7½
Width over head	13	17⅓	18.7	20
Width of metal outside hole	1½	...	6	10

We have directed prominent attention to the above error because it is really one of a most important kind, and one which, under certain circumstances might lead to disastrous results, for our author after giving the calculations we have criticised, goes on to say, "The dimensions of the chain and pins at every other joint may be similarly calculated, as also the suspension rods and pins by which they are attached to the main chain." With such ample published data as exists on this subject we cannot but wonder that such an error should have been allowed to creep into a book like Mr. Humber's, the more especially as in a subsequent chapter devoted to rivetted and other joints the author refers in a foot note to the experiments and conclusions of Sir Charles Fox, without, however, attempting to embody the results of these experiments in his own rules.

Mr. Humber's remarks about the proportions of chains and coupling pins are followed by examples illustrating the modes of calculating the proportions of cast and wrought-iron girders, diagram plates being introduced, showing the curves of moments for the bridge over Saltwater river, Australia, for the Staines Bridge, for the Victoria Bridge, Montreal, and for the Britannia Bridge. The explanations of the modes of carrying out the calculations in different cases are, for the most part, full, but we meet with further instances of that want of information concerning minor details to which we have alluded. Thus, in speaking of plate girders, our author states very properly that the webs should be prevented from buckling by affixing stiffeners at intervals, and he gives a woodcut showing the sections of stiffeners which may be used, but beyond this he makes no attempt to define the proportions of these stiffeners to be adopted in different cases, although this is just one of those points on which an engineering student is particularly likely to require information.

Dismissing the main girders, our author next treats of the flooring of bridges, and institutes a comparison between cast-iron flooring plates and wrought-iron buckle plates, greatly, of course, to the disadvantage of the former. The plan of turning arches in brickwork between the girders he merely mentions to record his opinion that, on the whole, it is not superior to a platform of flagstones—an opinion with which we cannot agree—while, as regards railway bridges, he recommends corrugated iron as far superior to planking for the purpose of filling the spaces between the girders, a recommendation which is also opposed to our own ideas on the subject. The different methods of constructing cross girders are next considered, as are also the various modes of attaching them to the main girders, this portion of the subject being illustrated by a plate showing a number of examples taken from actual practice, while another large plate is annexed containing a variety of elevations and sections of parapets, drawn to large scales. Next our author treats of the deflection of girders, and gives examples illustrating the method of calculating the camber which it is desirable to give to girders.

So far the practical explanation of the formulæ has referred to plate girders, and Mr. Humber next proceeds to deal in a similar way with the formulæ referring to lattice and trussed girders of various types, and speaks of the constructive details of such girders, while finally the chapter under notice is concluded by some data concerning bridges of great span, drawn from Mr. B. Baker's work on "Long Span Bridges" and originally published in our pages.

In the next chapter Mr. Humber enters upon entirely fresh ground, and treats "on the form of iron and the processes of its manufacture." Commencing with some general remarks on the characteristics of iron, our author proceeds to treat at some length of the different methods of moulding and casting, and next describes the general processes to which wrought iron is subjected in the course of its manufacture from puddled balls into finished bars or plates, a brief account being also given of Messrs. Howard and Ravenhill's mode of rolling solid-ended links for suspension bridge chains. Then come some remarks on the processes of forging, and these are followed by descriptions of various cutting tools, screwing tackle, and different machine tools, such as lathes, planing machines, shaping machines, screwing and drilling machines, punching and shearing machines, and rivetting machines, the accounts of these various tools being accompanied by general information as to the modes of using them. The whole chapter is one which, although it necessarily deals with the various subjects to which it relates in very general terms, will yet be of considerable use to those who have had no practical training in a mechanical workshop, as it will serve to give them a general insight into the nature of the processes by which the materials with which they have to deal are brought into their finished forms. We cannot but wonder, however, that in describing the various machine tools greater space has not been given to accounts of some of the more modern appliances of this class specially applicable to bridge work. With the exception of a description of Mr. John Cochrane's machine constructed for drilling the plates of the Charing-cross bridge, nothing is said of multiple drilling machines, although a variety of such machines applicable to general work are now manufactured, while no mention is made of the different types of automatic punching machines or of plate-edge planing machines. We do not attach any great importance to the omissions it is true; but we should like to see them supplied in a future edition, and we should also like to find some space devoted to a consideration of the treatment of steel plates, and the effect of the process of annealing such plates after punching, &c. As it is, the use of steel as a bridge-building material is almost ignored in Mr. Humber's treatise.

Chapter XIII., which succeeds that just noticed deals with rivetted and other joints, and we regret to see that it contains a repetition of the erroneous rules for determining the diameter of the pins for the chains of a suspension bridge to which we have already directed attention. Rivetted joints and their proportions are dealt with at considerable length, but, we think, in a less succinct style than might have been adopted, while the remarks on this subject are followed by others on keys, and gibs and cotters.

The last chapter of this section of the work before us treats of iron piers and foundations, and it is altogether a very interesting and important one, notwithstanding that it deals with iron foundations only. Commencing with remarks on the methods of bedding girders, Mr. Humber next speaks of cast-iron piles, and of cylinder foundations, describing the diving cylinder of Mr. Coode, Milroy's excavator, Pott's vacuum system, Hughes's pneumatic system, as used at the Rochester bridge and other important works, while, lastly, he treats of screw piles, and of the method of sinking disc piles in sand devised by Mr. James Brunlees. The chapter is illustrated by large plates, showing the details of Coode's diving cylinder, Milroy's excavator, and Hughes's pneumatic apparatus, whilst numerous references are made to the engravings of various bridges actually erected.

We have now arrived at the third or descriptive portion of Mr. Humber's treatise, and of this part, illustrated as it is by an extensive series of well executed plates, we are glad to be able to speak in terms of high praise. Indeed, this portion of the work alone, would render the book well worthy of a place in every engineer's library. Thus, first of all, we have an account of the bridge erected over the Medway at Rochester, by Sir William Cubitt, this structure with the swing bridge annexed to it, being illustrated by fifteen double plates, containing, besides the principle elevations and sections, large scale views of all the main details. Next comes the Standish bridge, a cast-iron arched bridge of 83 ft. 4 in. span, erected from the designs of Mr. W. H. Barlow, this being illustrated by two double plates, while the third on the list is Mr. Page's well-known Westminster-bridge, which has six double plates devoted to it. The fourth example is the Victoria-bridge, Pimlico, erected from the designs of Mr. John Fowler, which is illustrated by six double plates, accompanied by full specifications and tables of quantities, while a large diagram plate is added, showing the results of experiments on the strenth of the bridge. So far, the examples we have mentioned, have all been arched bridges, and next Mr. Humber illustrates and describes three specimens of wrought-iron plate girders, namely, the bridge over the Thames at Staines, the Trent-lane bridge, and Mr. Fowler's bridge over Saltwater river, Victoria. These bridges are illustrated by three, two, and one double plate respectively, while of the Saltwater river bridge a full specification is given, besides diagram plates of strains in an earlier portion of the book.

Triangular girder and trellis girder bridges are illustrated by nine examples, these being the Taptee

viaduct, the Jumna bridge, the Leven, Kent, Beelah, and Deepdale viaducts, the Londonderry bridge, and the Charing-cross bridge. These various examples occupy altogether twenty-eight well-executed double plates of general views and details, while the accompanying letter-press, besides containing general descriptions, includes several valuable complete specifications and tables of quantities. In the case of the Taptee viaduct, for instance, the descriptive matter embraces a number of valuable tables giving the comparative costs and other particulars of the various standard bridges and piers used on the Bombay, Baroda, and Central India Railway, these tables being accompanied by illustrative diagrams.

Wrought-iron lattice bridges are represented by four examples, namely, the Lerida, the Alcanadre, the Murillo, and the Carlos Gomes bridges, these examples, which illustrate different types very fairly, having six double plates devoted to them. Next we have wrought-iron bowstring girders, represented by the Windsor and Shannon bridges, while Mr. Brunel's Saltash bridge is also included in this class. The Windsor bridge is illustrated by three, the Shannon bridge by five, and the Royal Albert bridge, Saltash, by three double plates, while a large diagram plate showing the deflections of the Shannon bridge under proof is also added.

Lastly, we come to suspension bridges, of which Mr. Humber describes four examples, namely, the Lambeth, the Chelsea, and the Clifton bridges, and the Francis Joseph bridge over the Moldau, at Prague, the last-mentioned example being constructed on Mr. R. M. Ordish's "straight link suspension" system. The Clifton bridge is illustrated by three, the Lambeth and the Chelsea each by four, and the Francis Joseph by seven double plates, these plates being, in the latter instance especially, admirably detailed.

We have, we think, now said sufficient to show that the descriptive portion of Mr. Humber's work is of a most valuable kind, and we in fact know of no book of its class at all equal to it. With some of the other portions of the treatise we have had occasion to find fault, but the defects we have pointed out are far from being sufficiently important to materially affect the value of the work as a whole, and we can therefore commend the book to all those of our readers who desire to possess a good record of modern practice in the branch of engineering with which it deals.

MECHANICAL REFINEMENTS.

No. IX.

To the Editor of Engineering.

Sir,—Recently there have been presented to me two or three bold schemes; and, as they refer to subjects at present being discussed in Engineering, I will explain their nature in a simple way, letting others set their own value upon them.

First, in stopping railway trains: thus far there appears to be no safe way except that of putting brakes on the wheels; consequently, if brakes are applied to all the wheels of a train, and all tightened up to the point just below skidding, all has been done that can be by our present means to stop the train. That a train might be stopped much more suddenly, without destruction to itself or serious injury to the passengers, is evident by the many accidents that occur in which the passengers miraculously escape, and yet the trains are stopped by leaving the line, or other causes, in scarcely more than their own length.

Among the various classes of railway accidents, collisions and those caused by obstructions on the lines are not the least destructive, and if means can be provided to stop a train in one-half the distance now necessary, many might be avoided, or the fatal consequences mitigated to a greater or less degree; and when we consider the cost of a life of one person, even in £. s. d., it would seem to be worth while to try any means that promised improvement, and adopt it at whatever cost, if it proved a success.

Every engine driver has within his boiler a power sufficient to stop an ordinary train in a very brief space of time, had he the means to apply it, and the proposition is simply to open a hole in the front end of the boiler, and let it apply itself. As the pressure in a boiler is alike in all directions, a hole one square inch in area in its front would permit the unbalanced steam at the back to exert a retarding force on the engine in pounds equal to the square inch pressure in the boiler; hence, a hole 100 square inches in area, with the boiler at a pressure of 112 lb., would offer 5 tons positive resistance, or enough, I believe, to alone bring up a 200 ton train running at a speed of 22 miles an hour in about three-quarters of a minute, or in a distance of some 700 or 800 ft.

But whether these figures are correct or not is a matter of no consequence, and whether 100 square inches is too much or too little is not put forth as

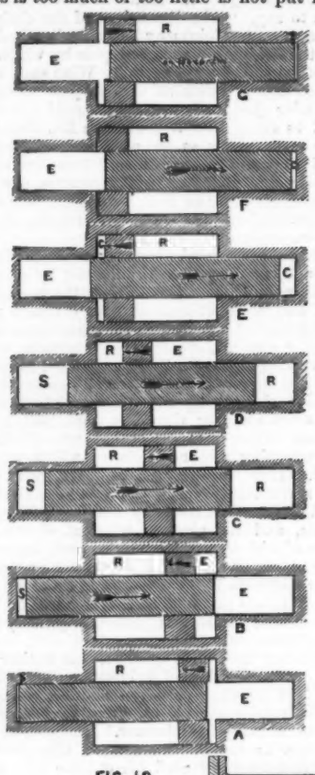
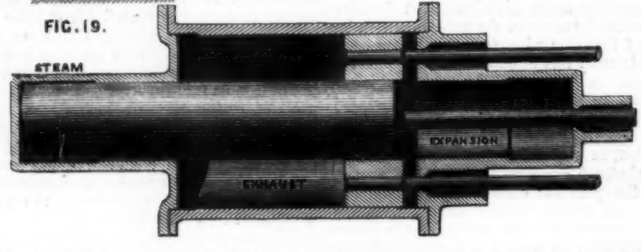


FIG. 19.



an opinion, the suggestion is simply that there is a force at command which, if added to the means we now have, a train may be so much the sooner brought up; what proportions the means, the cost, and consequences bear to each other, are questions that may be worth the consideration of railway engineers.

To the objection that through a hole of the enormous size of 11 or 12 in. in diameter the boiler will be blown dry of both steam and water in half a minute, the schemer replies, well, if it prevents an accident we can well afford to fill it up again. But the boiler will be ruined: very well, he says, if one human life is saved we can well afford to make another boiler; killing a man costs us from 5000 to 25,000 dols.—a new boiler don't. But if you should see a man ahead on the line, and opened your stop valve, you would kill him with the water and steam; to which he says, "I wouldn't open my stop valve, that is not the kind of accident my plan provides against."

In the matter of compound engines the idea conveyed by the sketch, shown in Fig. 19, is, so far as I know, new, and possesses one feature of merit that I have seen in no other design, that is, direct communication between the cylinders, without valves or passages. The two pistons connected to cranks set at an angle of 210°, would occupy the positions shown in the different diagrams, from A to G, taken at each 30° during 210° of one revolution. The space filled with live steam is marked S, the expansion, E, the exhaust or release, R, and the compression, C; by this arrangement the high pressure cylinder would exhaust into the low pressure one, when it had made 150° of the revolution. Whether simple valve motion and suitable packing rings for the small cylinders can be devised is left for inventors to determine.

At Figs. 20 and 21 is shown a new candidate for inspection in the inexhaustible field of balanced slide valves. At first sight it will appear to many as simply a modification of an old and discarded plan, but taken as a whole it is, so far as I know, new, and the most simple of any that I remember having seen. The valve itself, as will be seen, is a simple rectangular plate, with an opening completely through it, precisely like the steam valve in the Allen engine, but used to perform all the functions of the common slide valve, as will be readily understood by reference to the drawings. The back plate is not bolted down as in the Allen engine, but is placed within the steam chest, and held down on the supports, marked *a*, and the side ribs, *b*, by the pressure of steam. This admits of the valves being lifted from the face by an excess of back pressure in the cylinder. The peculiar form of the back plate is designed to overcome what at first seemed to be an impossibility, that is a plate

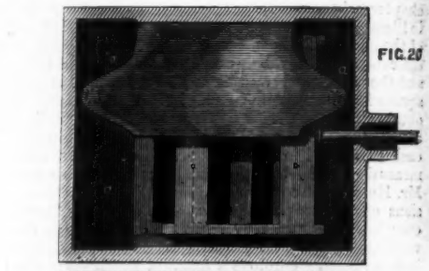


FIG. 20.

FIG. 21.

that would stand the pressure without springing. It is cast with a steam-tight chamber, the pressure coming on the dome-shaped top.

The valve, it will be understood, is very thin, not necessarily thicker than the width of the steam ports, and as the back-plate supports are subject to the heat of the steam as well as the valve, the valve does not get tight by expansion.

The whole thing is so simple that it would seem as if any skilled workman, by the aid of a Whitworth surface plate, could turn out a successful job without experiment, and as it is not covered by any patent, nor is it an infringement on any, I see no reason why it should not be extensively used.

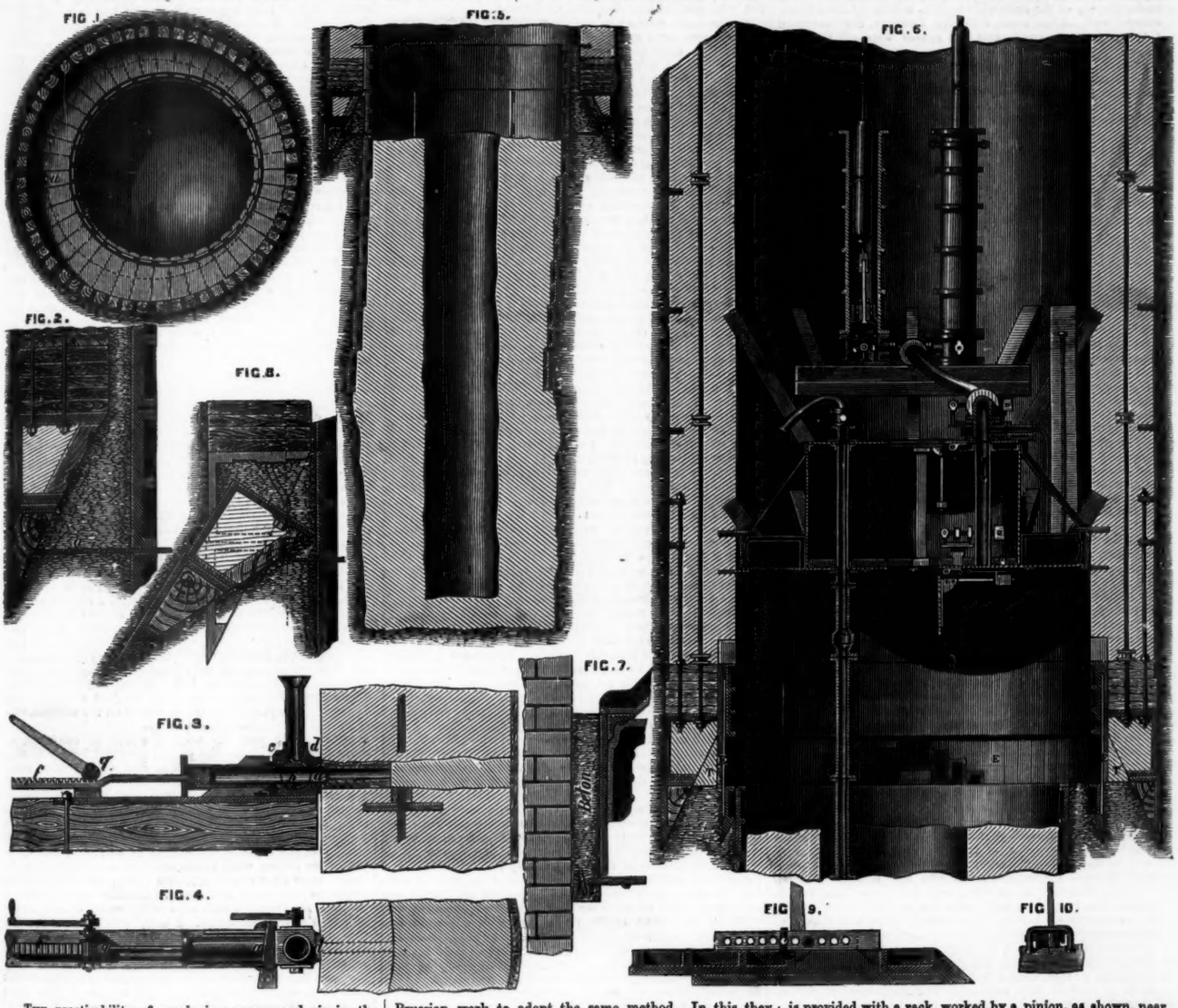
I am, yours truly,

An English Engineer in America.

A Nice Calculation.—It is intimated that there are 1,229,200,000 cubic feet of water delivered annually from rivers in Maine into the ocean, falling 600 ft. This fall of water would provide a force equal to 2,656,200 horse power, or as much as the labour of 34,000,000 men for one year without intermission.

Telegraphy in Australia.—The accounts received from the working parties engaged in the construction of the great Australian overland telegraph continue favourable. Section A is expected to be completed in the course of this month. On Section B 70 miles of posts had been erected at the date of the last reports. The five Government parties expected to be able to concentrate all their energies upon the 350 miles, more or less, of line extending from the Macdonnell Ranges to the extreme southerly point of Messrs. Darwent and Dalwood's contract. Altogether the South Australian Government confidently expects to be able to carry through all the arrangements which it has made with the British-Australian Telegraph Company.

SHAFT SINKING THROUGH WATER-BEARING SAND NEAR HOMBERG.



THE practicability of employing compressed air in the sinking of shafts to great depths was proved by MM. Blees and Althan, engineers attached to the Prussian Corps of Mines. Experiments made in 1857 and 1859 during the repairs of the tubbing of the Maria shaft, near Alsdorf, in the Worm basin showed:

1. That in fine and water-bearing sand the pressure of air necessary to dry the ground in which the workmen are engaged is much less than that due to the head of water. In the Maria shaft the pressure did not exceed three-fourths of an atmosphere, whilst the head of water was more than 49 ft.

2. That when the air pressure is removed from such sand, the water does not reappear for a considerable time. In the same shaft periods of 24 hours elapsed before its reappearance.

These results can only be explained by the capillarity of the fine sand, which opposes to the movement of the water resistances which are not met with in material of a coarser nature. In 1866 the *Revue Universelle* described a scheme for the application of compressed air for deep borings. This project was intended for application to a shaft in Rhenish-Prussia, near Homberg, in the sands of the Rhine.

The sinking of the shaft had commenced in 1857, and still remains unfinished, despite the uninterrupted labour bestowed upon it. The application of compressed air was deferred as long as possible, on account of the fears that were entertained if it were adopted. It was only in 1865, when the engineers were at the end of their resources, that it was determined to resort to it. The depth below the water level was some 250 ft.

The sinking of the Rhenish-Prussian shaft was commenced, as we have said, in 1857, by the descent of a curb in masonry, 2 ft. 8¼ in. thick, and 25 ft. 4 in. diameter. When a depth of 72 ft. had been reached, the curb refused to advance, although it was loaded with 500 tons of pig iron. The success obtained by the process of mechanical dredging at Alsdorf (hand dredging had been previously employed in this work) encouraged the concessionaires of the Rhenish-Prussian work to adopt the same method. In this they were successful, and a second masonry shaft, of reduced diameter, was sunk to a depth of about 250 ft., but this achieved, nothing more could be done, despite the application of the powerful hydraulic presses. Afterwards a cast-iron curb was used, the diameter of the shaft was reduced to 14 ft., and the dredging was resumed. During the course of the work this curb descended suddenly through more than 36 ft., and was brought up on a bed of argillaceous sand mingled with hard boulders. This mishap repaired, the sinking proceeded with more or less success, but ultimately it was found that the unsafe nature of the ground imperilled the safety of the whole shaft. Under these circumstances, and in order to save the work already completed, it was determined to fill the boring with béton up to the level of the cutting edge of the masonry curb, as shown in Fig. 5, at a depth of some 250 ft. from the surface.

This succeeded perfectly, and the shaft was soon drained with buckets. There remained between the second masonry revetment and the iron curb an annular space in free communication with the water-bearing strata, and it was necessary to prevent any influx through this area. A series of flat trapezoidal plates were placed horizontally on a joint of the iron revetment, corresponding to about the middle of the cutting edge below the stone curb, as shown in Figs. 1 and 2. This contrivance was sufficient to suppress all influx of sand, although it was far from being watertight, especially on that side where the iron curb, which occupied an eccentric position, nearly touched the stonework. A number of small cracks in the stonework were carefully closed with broken brick and cement. At a depth of about 216 ft. there was found a fissure almost horizontal, and some 3½ in. wide, by which the curb was really divided into two parts. The binding bolts themselves were broken, and the fissure admitted the passage of water and sand; the sides of the fissure were somewhat equalised, and a ring formed of oak blocks was placed in it, and the space at the back was filled in with cement by a force pump, as shown in Figs. 3 and 4.

It consists simply of a barrel and plunger, the rod of which is provided with a rack, worked by a pinion, as shown, near the end of the barrel, and in free communication with it is a vertical tube, and a two-way cock, which is turned at each stroke of the piston. Two of these pumps placed in different points of the fissure, forced in the cement which was fed through the vertical pipe at a pressure of 14 atmospheres.

Before deciding upon the best means for continuing the work, it was deemed advisable to ascertain the condition in which the iron curb remained. To this end a shaft was sunk in the béton, and at different levels horizontal holes were bored up to the ironwork. This investigation showed that eight segments were intact, but greatly out of position (Fig. 5). At the same time it was found that besides 10 segments that had broken and been removed, 5 segments were wanting, and the position of them could not be ascertained. This discovery showed the impossibility of sinking a new iron curb in the shaft of suitable dimensions to pass through the length where the revetment already sunk had become distorted. It was then decided definitively to lift completely the iron revetment. For this work the use of compressed air appeared the only means possible to prevent the irruption of sand into the working. The apparatus was constructed for a working pressure of 2¼ atmospheres, the lower side of the air chamber entirely closed the shaft, and it was solidly built into it, a little above the cutting edge of the stone curb, as shown in Fig. 6. The air pumps were placed above the level of the chamber; they were worked by the existing pump rods, which had previously been used for draining the shaft, and they were loaded to overcome the air pressure. The first work was to construct beneath the shoe of the masonry curb, and behind the iron revetment, a masonry ring, intended to consolidate the lower part of the stonework, which was in a very bad condition. This ring was seated on the horizontal closing plates before described. In this work the segments of the metal revetment were lifted two by two, in such a manner as to replace them instantly on the first signs of danger, and to uncover as little earth as possible.

The work commenced well. The sand was easily held

back under a moderate pressure. But new difficulties were met with; the shoe of the stone curb was found to be broken, as shown in Fig. 8, and its position prevented the intended underpinning of the curb with an iron revetment from being carried out. After some, difficulty, however, the fractured portions were renewed, and the spaces were all carefully built in with masonry. After this was completed, iron curbs, seen at F, Fig. 6, were carefully put in by the help of iron poling-boards (E, Fig. 6), 64 of which were used to make the circle, and which were got in position prior to placing in the iron revetment. Gradually, and with infinite labour, the fissures at the various parts of the shaft were stopped effectually, not, however, without fatal accidents.

The whole of the work is interesting as an example of the difficulties attending the sinking of shafts through water-bearing sand, and of the appliances and perseverance which finally saved a work over which 2,625,000 francs had been expended. We are indebted to the *Revue Universelle* for the particulars and sketches from which our drawings were prepared.

RAILWAY GAUGES.*

By R. F. FAIRLIE.

I HAD the honour last year of reading before this Association a paper upon "The Gauge for the Railways of the Future," in which I pointed out the capacities of narrow-gauge lines, and showed how unfavourably our own railway system, as at present worked, contrasts with such lines when properly handled. The great truths I then put forward were too startling to be received without some degree of ridicule and incredulity; and although I announced them in the full conviction that sooner or later they would be fully acknowledged, I was then little prepared for the rapidity with which that acknowledgment has come.

The report of the Imperial Russian Commission upon the Festiniog Railway produced a similar inquiry on the part of the Indian Government. I had once more the satisfaction of attending a Royal Commission, appointed to investigate the question of narrow gauge; and the results obtained on the second occasion were as satisfactory as those on the first.

In Russia, at the instance of His Excellency Count Bobrinskoy, H.I.M. the Emperor, commanded a line of narrow-gauge railway to be at once commenced, and a number of my engines to be constructed, in order that the accuracy of all I had asserted on the subject, and had shown to the Commission upon the Festiniog Railway, might be proved upon a more extended scale, and that the exact value of a narrow-gauge system, for national service, might be ascertained by the fullest tests of experience.

The Association will, perhaps, pardon a brief digression, while I here place on record, as a matter of history, the eminent services rendered to the cause of narrow-gauge extension by the Russian Commission, and also by Mr. Spooner, the engineer and manager of the Festiniog Railway. This little line, of only 1 ft. 11½ in. gauge, was originally constructed for horse traffic, but was worked after a time by small locomotive engines, resembling, in everything but dimensions, those in common use in England. As thus worked, the traffic outgrew the carrying capacity of the line, and powers to construct a second track were actually obtained. At this conjuncture Mr. Spooner had the sagacity to perceive the advantage that would accrue from the employment of my system of traction, of which he had read, and he determined to carry out his perception to a practical issue. I constructed for him the now well-known "Little Wonder" locomotive, and thus gave him, on his single line, two-and-a-half times the carrying capacity that he had possessed before. The second track was thus rendered unnecessary, and it has never been made. In the application of all novelties there must ever be risks of failure from unforeseen causes, and hence many, even when they recognise a truth, shrink from the responsibility of being the first to carry it into practice. The acceptance of this responsibility by Mr. Spooner, the opportunities that he thus afforded me of proving the working value of my principles, and the facilities for inspection and experiment that he has since courteously allowed, all fairly entitle him to be considered the father, as his tiny railway has certainly been the cradle, of the narrow-gauge system of the future.

The next step was made by the Russian Commission. It would be difficult for me to do justice to the infinite care and pains with which Count Bobrinskoy, the president of that Commission, investigated every detail before arriving at his conclusion, or to the earnestness with which he afterwards pushed this conclusion to its legitimate results. In Russia, as in other countries, there are men whose interests or whose prejudices lead them to cling to existing systems, and the opposition which proceeded from such persons could only have been overcome by the strength of clear convictions, of unsullied integrity, and of indomitable resolution. Count Bobrinskoy was worthily assisted in his novel and important duty by the other members of the Commission, among whom I may name M. B. Saloff, professor at the Technical School of Engineering, St. Petersburg; M. von Desen, now resident engineer in charge of the works; and M. Schoubersky, in charge of the rolling stock of the Imperial Livny Railway. To these gentlemen the entire civilised world owes a deep debt of gratitude. The line, which was constructed and equipped in accordance with their report, has now for several months been in operation. The results of its working establish all that I claimed for the narrow gauge, and the final official trials that will take place this month will determine the general adoption of the 3 ft. 6 in. gauge in Russia, together with the employment of my locomotives, without which the value of the narrow gauge at once sinks into comparative insignificance. This rapid action is due to the promptness with which His Imperial Majesty of Russia appreciates progress, to his freedom from prejudice, and to the fact that I have never advanced anything which I have not been able to prove.

In India, although I believe ground has not yet been broken, a metre gauge has been decreed for general introduction; and the strongest advocates for the retention of the 5 ft. 6 in. gauge have been entirely defeated.

In Australia, Tasmania, and New Zealand, narrow gauge railways have been undertaken, and will be built as fast as means that have been straitened, and opinions that have been prejudiced, will permit.

In South America to a great extent, and in North America—I speak of the United States—to a marvellous degree, the reform I have so long, and at last so successfully, advocated, is making way with an astonishing rapidity. Some 2000 miles of narrow gauge line are under construction; the Great Denver and Rio Grande Railway, 850 miles in length, is being built upon the gauge I have made specially my own; and I may mention that this width of 3 ft. was decided upon by the president and principal officers of the company, after considerable investigation of the principles of my system recommended to their consideration by Mr. George Allan, C.E, who at an early period became strongly convinced of its advantages. A great transcontinental railway from the East to the Pacific is being organised, also on the Fairlie gauge. California is building similar lines; the western states and territories, pastoral, agricultural, and mineral, are building them; Massachusetts, already covered with a network of ordinary gauge railways, is legislating for them; and many others of the eastern states are earnestly considering the advisability of their immediate construction.

As little as yourselves could I have last year imagined that all this progress would have been made in less than twelve months. At that time I was discouraged on almost all sides; I was hampered by the weight of prejudice and of opposition of every kind; but knowing I was right, knowing that the work I had in hand was one which would benefit the whole of the civilised world, knowing that, could I once produce conviction, there need be no country, however poor, that could not be supplied, no distance, however great, that could not be traversed by profitable railways, I persevered, and to-day I find that my efforts have been crowned with a great and substantial success. Need I say that I appreciate this victory, counting the past pains as nothing, and being still more encouraged to continue advocating the truth.

But it is only due to this Association that I should state how much of my success I owe to its influence, and to the weight thus added to my now celebrated paper on "The Gauge for the Railways of the Future." To that paper I attribute a large proportion of the extraordinary activity that I have described. Stamped with the approval of this Association, the paper has circulated in all countries, and has been translated into all European languages, including those which have been naturalised in South America. It has formed the text for innumerable discussions; it is almost daily quoted in the journals of the United States, and it has excited the most lively interest among the railway engineers of that country, where existing railway management shows results still more discouraging than those which are obtained in England. The British Association, therefore, more than any other public body, has helped forward a vast reform, and gratefully feeling this, I am encouraged to come here again on this occasion.

It is not long since, that to doubt established gauge was heresy. A type to which an accident had given birth, had come in course of time to be considered perfect; it was a superstition quickened into a religion. By degrees, after scores of thousands of miles of railway had been built, and hundreds of millions of pounds expended, it began to be seen that there was something still to be desired, and that it was ruinous to make railways for the service of remote districts yielding but small traffic, or in countries whose limited means and commerce could not justify large expenditure. By this time the great outlay which attended the labours of the earliest engineers, the outlay involved by heavy works to gain easy gradients, had been somewhat reduced, and with improved locomotive practice, steeper gradients and sharper curves became possible. Then came the very recent modification of making essentially light lines upon the standard gauge, conforming as much as possible to the natural contour—surface lines, as I was the first to name them in 1864. By adopting them the cost of construction was greatly reduced, and was brought somewhat more into proportion with the revenue to be derived.

But these improvements were but improvements upon a bad type, and real reform could not be effected whilst the width of gauge remained, while the rolling stock continued unaltered, and the locomotive rested unmodified.

Meanwhile, the history of railway construction in England was slowly repeating itself, even in an exaggerated form, abroad, and particularly in our colonies, where the primitive types were perpetuated by the pupils of the old school of engineers. And here I may remark that the difficulties encountered in this country in railway reform have been faithfully repeated in our colonies—an illustration of cause and effect. Gradually it became known that the ruinous practice of English engineers in Norway had forced the Government of that country to adopt an entirely new type, after the intermediate stage of light standard gauge railways had been largely tested and abandoned, and that for the first time a national narrow gauge system was established. But this was done so quietly, and information filtered so slowly from that isolated country, that until quite recently only a few have known of the change, and still fewer have known, or have cared to inquire, about the practice followed or the results obtained.

Of course, exceptional and independent lines of very narrow gauge, established almost universally for mineral traffic, have existed for many years; but these, with the exception of the Festiniog Railway, do not enter into the question; on the contrary, indeed, their small traffic capacities, as worked, have served the opponents of narrow gauge as arguments against innovation.

So matters stood when I, having convinced myself of the monstrous errors which cripple our standard railway system, and having learnt the capabilities of narrow gauge—which are yet scarcely understood even by the engineers who are advocating and constructing them—so matters stood when I first devoted myself to the effort of promoting the general introduction of narrow gauge lines, and had the audacity to set myself up in opposition to long established and decipyrrated principles. At first the utmost concession I could obtain—a concession granted but by a few—was that for new countries, where railways did not exist, or for poor countries, where traffic was light and uncertain, a narrow gauge system might be adopted with some amount of advantage; but that its capacity and consequent utility were proportioned to its gauge; and that hence, as a natural consequence, not only must such lines as I recommended be located in districts where only a very small business actually existed, but where also the prospects of its increase were extremely remote. I knew the error of this opinion, for I knew the actual capacity of narrow gauge railways under proper management; therefore I was encouraged to persevere until, as the circle of conviction widened, I was enabled to put my views to the test of actual and wide experience, and to stir into life the radical reform which to-day is spreading on every side, and which shall before long become general.

I showed you last year how, upon a railway costing one-third less than a line of an ordinary gauge, I could with equal despatch carry such a traffic as that of the London and North-Western Railway, with a saving of three-fifths of the dead load carried; and how in so doing I could effect a corresponding reduction in engine power, and consequently in cost of fuel, of rolling stock, of engine repairs, and of maintenance of permanent way. All this could be effected at a speed at least equal to the present speed of freight trains for the goods traffic, and at 35 miles an hour for the passenger traffic; a rate which is but little below the average of the mileage made by fast passenger trains in this country. We are so accustomed to the present condition of things—or, perhaps, we are so ignorant of the real elements of railway economy—that it is difficult to believe this great reform possible, but belief was more difficult a year ago than it has since become, now that all my statements have been proved to be incontrovertibly true. The question, however, is one of such radical importance, that I may once more devote a few words to its elucidation.

On the London and North-Western Railway the average practice is to employ 7 tons of wagon to carry 1 ton of goods, but I assume the proportion of dead weight to be only four to one, in order to make out as favourable a case as possible. The average weight of a goods train on the London and North-Western Railway is 250 tons; composed, in the proportions I have mentioned, of 50 tons of freight to 200 tons of rolling stock. (See diagram*.) On the Livny (New Russian), 3 ft. 6 in. railway, on the other hand, the average gross weight of trains is 354 tons, or 104 tons more than that of the London and North-Western, while the dead weight is only 94 tons. This proportion is also shown on the diagram. To carry this paying load of 260 tons on the London and North-Western, 1040 tons of wagons would be employed, or more than eleven times the weight required by my system. In all my arguments, I of course deal with general goods traffic only, exclusive of minerals. It may be urged against this comparison that the more favourable traffic conditions of the Livny Railway help the results; but it is sufficient to reply, first, that with the reduced gauge reduced weight of wagons in proportion to capacity is feasible; next, that the smaller wagon capacity is essential to economy; and third, that while rolling stock of the smaller class is certain to be loaded more nearly to its ultimate limits, the difference between the maximum load, and the absolute loads obtained in practice, are attended with none of the excessive cost inevitable on a 4 ft. 8½ in. gauge. I would here call your attention to a most important fact in connexion with railway goods traffic. The average load of merchandise carried by each wagon in this country is considerably less than 1 ton. Experience has proved that the exigencies of traffic in this country have settled this average, yet wagons of four times this capacity must nevertheless be provided. This fact of itself is sufficient to show that so broad a gauge as the standard one is very excessive. With a narrow gauge this evil may be prevented, and if a higher average per wagon could not be attained, at least a far lower proportion of dead weight would result. This I have endeavoured to make apparent in the diagrams, which show the average proportions of dead to paying weight on the 4 ft. 8½ in gauge, and on the 3 ft. gauge; and I have also placed the load carried as the average by the standard gauge upon a train running on a 3 ft. gauge, the varying proportions being well expressed by contrasted colours. The great economy in working, brought about by the causes enumerated above, would react upon railway business, and in increasing it would certainly raise the wagon average, because the cost of carriage would be so much reduced.

I think you will agree with me that I am no visionary, but have always spoken within the mark, making my position sure as I advanced, and asserting nothing that I could not prove in actual practice. I have obtained, by the development of my system, results very closely approximating to those I stated last year—namely, three to one of paying to dead load, and I know that this proportion can and will be reached when my views are fully carried out, when a Fairlie gauge is worked with Fairlie locomotives and stock; while by no other system in existence can such results be obtained.

(To be continued.)

* Paper read before Section G of the British Association.

* This diagram, with the others subsequently referred to, will appear in our next number.

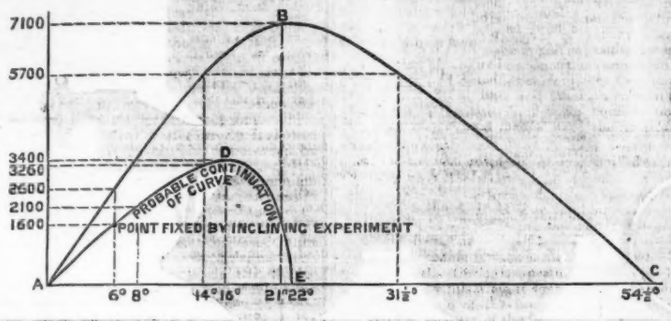
THE ENGINEERING TRADES.—In Glasgow and the Clyde district generally the engineering trades are still as busy as ever. The sugar machinery firms and the marine engine firms are especially busy. In some instance there is a great fear lest any misunderstanding regarding wages or the short time system should arise with the workmen. The great activity in the engineering trades is not limited to the West of Scotland, as it also exists in the east, although not to such an extent.

THE LOSS OF THE CAPTAIN.

TO THE EDITOR OF ENGINEERING.

SIR,—As the loss of the Captain and the cause of that loss are occupying so large an amount of public attention, and the questions involved being of national importance, I would hope that the following information on the subject may be deemed acceptable.

Circumstances having led me to take a great interest in the loss of the vessel and in the proceedings at the court-martial, I was surprised to find that, with such an extremely good curve of stability, as produced in evidence by the Constructive Department, that the vessel, according to the finding of the court, could be said to have been lost for want of proper stability; and yet I perceived that there was other evidence which did show that she was actually lost from that cause.



Here was a striking discrepancy. The vessel was evidently lost for want of stability, while the official curve of stability was such that, if the ship had really possessed it, no pressure of wind upon any extent of sail she could possibly have carried could have forced her over.

Pondering over this conflict of evidence, I was led to question the correctness of the curve of stability as laid before the court-martial. To my surprise I found it to be grossly incorrect, and not even agreeing with the inclining experiment which had been made at Portsmouth in order to ascertain the position of the centre of gravity.

The inclining experiment, as stated in evidence by Mr. Barnes, proved that 80 tons placed on the deck at 20 ft. from the centre line, heeled the ship 6 degrees, and this, of course, was the measure of her stability at 6 degrees. This 80 tons multiplied by the 20 ft. gives 1600 foot-tons as her stability at 6 degrees; while the curve produced in court showed a stability, at 6 degrees, of no less than 2600 foot-tons.

The rest of the curve was in still greater error. It showed about three times the value of the real stability possessed by the ship, as deduced from the inclining experiment.

The official curve gave 7100 foot-tons as the maximum stability at 21½ degrees; with a stability of 5700 foot-tons at 14 degrees which was retained up to an angle of 31 degrees; while, in point of fact, the highest real stability of the Captain was only about 3400 foot-tons at 16 degrees—3260 at 14 degrees, and which she carried only up to 18 degrees.

It seems never to have occurred to any one that the inclining experiment which was undertaken to enable the position of the centre of gravity to be ascertained, that said experiment at the same time ascertains the stability of the ship at the angle taken. Yet nothing can be more certain. Indeed, the whole curve could easily and quickly be worked out by inclining experiments alone, taken at different angles, without any reference to the centre of gravity whatever, and without any elaborate calculations with their attendant risks of mistakes.

The grievous error in estimating the stability of the Captain, which I have pointed out, will explain everything. The authorities thought she had the stability as represented by the official curve; and consequently sent her to sea. She had it not, and, consequently, was lost.

I forward a diagram showing the official curve, and also the curve agreeing with the inclining experiment.

I am, Sir, your obedient Servant,

M. W. RUTHVEN, C.E.

St. Paul's-road, Burdett-road, August 15, 1871.

THE GREAT EASTERN DRY DOCK, MILFORD.

TO THE EDITOR OF ENGINEERING.

SIR,—Having read in your columns of the 4th inst. that a dry dock is designed, and is to be constructed at Milford for the Great Eastern, I ask your permission to state (so as to prevent an erroneous impression prevailing that the Great Eastern only was to use the dock, and bear all the expense), that a limited company is being formed of all parties interested to build the said dock, and, at such times as the Great Eastern does not occupy it, to allow other vessels to be docked, repaired, and load or discharge, say from 20,000 to 30,000 tons, and that to a large profit.

The site chosen for the Great Eastern Dock is known on the map by the name of the Old Dockyard. It is bounded on the south and west by the Hubberston Pill, on the north by the Great Western Railway to Newton Nores, having the entrance from the east, about 250 ft. from the steamboat pier. Its length is about 700 ft., width of entrance 90 ft., with a 27 ft. depth of water. It was designed by Mr. H. Wimshurst, and it has been approved by Government and other officials.

The grant of foreshore was obtained from the Admiralty under date, August 1st, 1871.

The foreshore is covered with shingle and sand over the rocks on which the dock will be built; and although there is a great rise and fall of tide, there is no current to interfere with docking. Its locality and advantages are incomparable, and as admitted by commercial men conversant with such matters, that there is not a better opportunity for investment. It is far out to sea, yet near the midland counties and London also by railway in a few hours.

I remain, Sir, yours obediently,

H. WIMSHURST.

Azim Ghur, Anerley-road, August 15, 1871.

INDIAN ENGINEERING EXAMINATION.

TO THE EDITOR OF ENGINEERING.

SIR,—In your issue of the 11th inst., in reference to the Indian engineering examination, you say "of course all sorts of explanations are given by the candidates themselves to account for the smallness of the number who passed."

I believe I failed in Applied Mechanics. Are these Applied Mechanics?

Paper No. I.—"9. Explain the following paradox: The centres of the two ends of an uniform cylinder are fixed at the same level, and the cylinder is then divided by a smooth vertical plane at right angles to the axis into two unequal parts of weights, W, W′, and lengths $2a$, $2a'$. Suppose R to be the resultant mutual pressure between the two portions acting in a horizontal line at a height, x, above the fixed point; then taking moments about each fixed point for the forces acting on the adjacent portion of the cylinder we get the two equations, $W a = R x$, $W' a' = R x$; whence $W : W' = a' : a$; but $W : W = a : a'$, or the results are inconsistent.

"10. A uniform wire in the form of an ellipse whose axes are $2a$, $2b$, is supported by passing over two smooth pegs in the same horizontal line at a distance, c, from each other; prove that in the position of stable equilibrium the angle which the major axis makes with the vertical is $\tan^{-1}\left(\frac{b}{a}\sqrt{\frac{c^2-2b^2}{2a^2-c^2}}\right)$, provided this quantity," &c.

Paper No. II.—"8. A smooth hemispherical vessel stands on a horizontal table; above it is a smooth conical funnel having the same axis as the hemisphere. The funnel is filled with a block of ice, which is made to rotate about its axis; the funnel is then heated so that the ice melts and the water falls through apertures into the hemisphere, which it exactly fills when it again becomes frozen; if 2α be the vertical angle of the funnel, compare the original and final angular velocity of the ice."

It will be found, upon referring to the papers, that, with the exception of one or two, the remainder of the examples are similar to the above.

C. GRAHAM SMITH (No. 7) Stud. Inst. C.E.

39, Warwick Gardens, Kensington, W.,

August 16, 1871.

TO THE EDITOR OF ENGINEERING.

SIR,—As a regular subscriber to your valuable journal, I hope you will allow me to make a few remarks on the recent examination for engineers for India.

The result, as you say, is startling, but at the same time do not the considerations you have mentioned rather show that the candidates have been treated unfairly; the engineering papers were indeed a very great improvement, in fact, I cannot imagine how they could have been better, as they comprised the whole subject, and any candidate, no matter what sort of work he had been accustomed to, would find questions which he ought to be able to answer.

Under these circumstances is it not strange that out of the whole of Great Britain and Ireland not one young engineer can be found to compete for an appointment who will do more than just qualify. As it is a remarkable fact that the candidate who passed first obtained only 54 marks above the minimum; in other words, he did hardly more than qualify, while as for obtaining anything like 1000 or even 800 marks, that was out of the question.

As regards the medical part of the business, I should like to give two specimens of how we were treated. One candidate was refused on account of varicose veins, but, on going privately to see one of the doctors of the Board, and saying he did not believe he had any, was re-examined and pronounced fit! May there not be other cases like this? He was admitted the third day of the examination. Another candidate was refused on account of short sight, who, before preparing himself for the examination, had consulted the head of the medical board, who told him his short sight would not make any difference.

In conclusion, does not the whole thing look like a farce, that instead of the Indian Government wanting *twenty* young engineers, would they not be perfectly satisfied with half a dozen?

Yours truly,

ONE OF THE SUFFERERS.

THE PATENT LAWS.

THE chairman of the recent meeting of London Patent Agents—Mr. George Haseltine, M.A.—has received from the Hon. Charles Mason, Ex-Commissioner of U.S. Patents—to whom were submitted the resolutions on "Patent Law Reform," which appeared in ENGINEERING last month—the following interesting letter. Judge Mason was a most able and popular Commissioner, and is a gentleman of the highest legal and social position:

"Your favour reached me at a distance of a thousand miles from the city of Washington. In reply, I have the honour to say that an experience of nearly twenty years has enabled me to form opinions, in some degree satisfactory to myself, on most of the topics therein presented. These I will now briefly state.

"I have never had any serious doubt of the wisdom of a judicious system of patent laws. If they create a monopoly, and thereby limit the rights of others, they do nothing more than is inseparable from the institution of property of any and every kind. The owner of a horse or of a tract of land enjoys the same monopoly as the patentee, except that it is perpetual. It is difficult to find a reason for the protection of property in the one case, which would not apply with equal force in the other. Who can more justly claim the exclusive use of anything whatever, than he who has brought it into being? And what reflecting mind can doubt that the public welfare will in the main be best promoted by inspiring individual effort in respect to invention, through the same motive of private advantage as that which can alone excite it to the needed intensity in all the other walks of human life? It is sometimes replied that an inventor is entitled to the machine which he has invented and constructed, and to nothing more. But this does not present the true analogy. The subject matter of an invention is not the material body, but the living spirit and principle which may animate an indefinite number of bodies of the same general character, though all varied in mere form or the materials of which they are composed. Mechanical labour and skill can produce the one, inventive genius can alone create the other. Each is equally entitled to the favour of a just government.

"The system of examination which has been adopted here is manifestly productive of much advantage to the public as well as to the meritorious class for whose benefit the law is more immediately intended. I have doubts, however, as to the wisdom of lodging in the Patent Office a power of rejection as unlimited as that which it now exercises. If the action of the examiners were merely advisory and adjuvant, leaving to the applicant the ultimate right to take his patent at his own risk after an adverse report, some of the chief objections to our system would be removed. I am inclined to believe that some such modification would be an improvement.

"By all means the patent fees should be small—barely sufficient to defray the expenses of the office. No other class of men does so much to promote the welfare of mankind as does that of inventors, and there is none that on the average is so poorly compensated for what they have done. To require them to pay a tax for the general support of the government, over and above that which is imposed upon any other class, is calculated to discourage their efforts, and to check the progress of civilisation in this most important particular. This does not seem sound policy.

"Our American experience leads me to the conclusion that fourteen years is too short a limit for the lifetime of a patent. In most cases of real merit the old fourteen year patents are extended by the Office to twenty-one years, and often by special act of congress to twenty-eight years. The new law fixes a seventeen year limit, and withholds from the Patent Office the power of extending the same. I have little doubt, however, that many of these seventeen year patents will hereafter be extended by congressional action. I do not think that twenty-one years is too long a period for their general continuance.

"I like the British system better than ours in one particular. Your fees are paid in instalments, leaving the inventor the right to keep the patent alive or not, at his option. If that plan were in operation here, a considerable proportion of our patents would terminate their existence shortly after their birth. This would remove out of the way many useless patents which now act the part of the dog in the manger, and will never be heard from during their whole seventeen years, unless some subsequent inventor shall make some improvement thereon, which will make useful what would otherwise be worthless. Nothing is more common in our experience than after some highly useful invention has gone into successful operation, to find some unexpired patent which is worthless in itself, all at once revived and amended through a reissue, in such a way as to render the really meritorious invention subordinate. The courts often hold such useless patents invalid, but this does not protect the subsequent patentee against being greatly harassed and annoyed. As far as practicable, it would be desirable to prevent difficulties of this nature from presenting themselves. The French plan of annual payments is carrying the matter rather too far. I like the British system in this respect better than either the French or the American, and believe that nothing is wanting therein but a diminished rate of fees.

"In relation to experts, they are often very useful, but those who are professional are looked upon with much suspicion, and their opinions have little weight with either court or jury. In this way, what might otherwise be a great evil carries with itself, to a great extent, its own remedy. And as to jurors, their interposition is generally avoided by proceedings in Chancery to obtain injunctions, which are the most usual remedies for infringements with us."

EAST INDIAN RAILWAY.—The traffic results obtained on this railway, during the past few months, have not been satisfactory. It is proposed, in consequence, to make a reduction in the company's staff of engineers.

COAL WAGONS ON THE BALTIMORE AND OHIO RAILROAD, U.S.A.

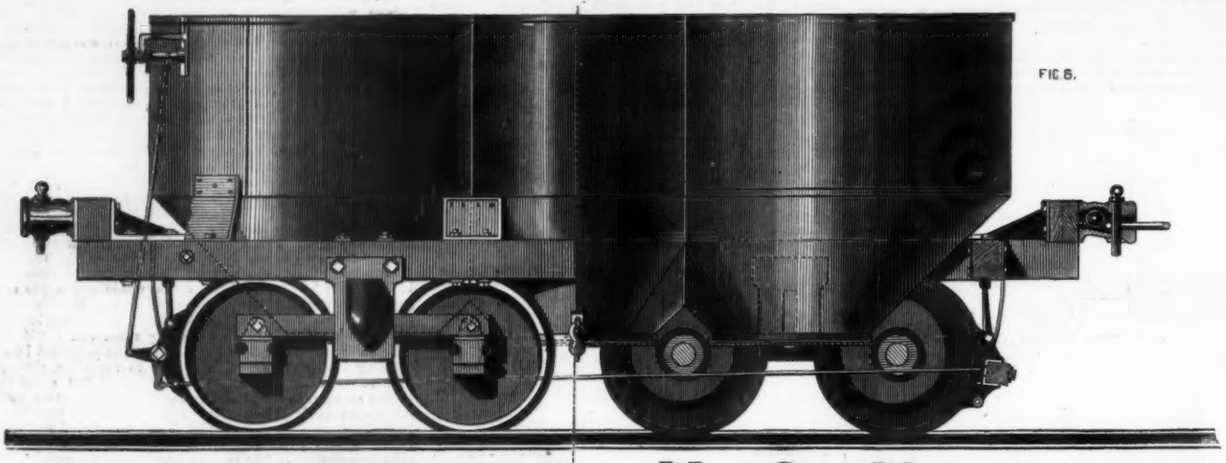


FIG 8.

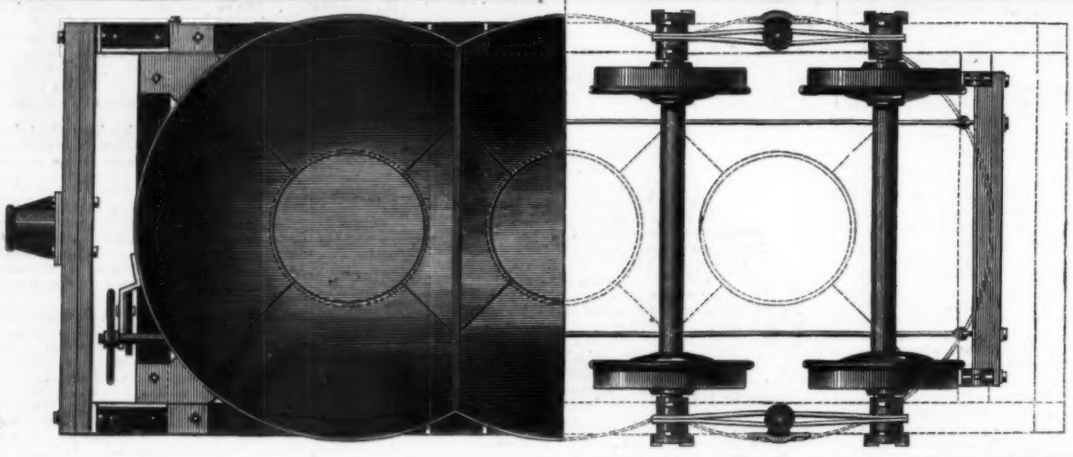


FIG 9.

FINNEMORE

WE illustrate, above, an example of a class of iron coal wagons in use on the Baltimore and Ohio Railroad, a line having a large coal traffic from the mines of the Cumberland district, Maryland. The wagons used are of two classes with six and eight wheels respectively, the wagon of which we give engravings being, as will be seen, of the eight-wheeled class. The frames are of wood, but the bodies are of sheet iron, the bodies of the six-wheeled wagons consisting of two, and those of the eight-wheeled wagons of three, compartments arranged in the manner shown in the section and plan. From these views it will be seen that the compartments are portions of cylinders tapered at the bottom to form hoppers leading to the discharging doors. The compartments are 6 ft. 10½ in. in diameter and the parallel and hopper portions of each are respectively 2 ft. 9½ in. and 2 ft. 5½ in high, the total height of each compartment being thus 5 ft. 3 in. The diameter of the compartments at the bottoms of the hoppers is 2 ft. 5½ in., and their distance apart from centre line to centre line of cylinders is 3 ft. 5½ in. The compartments are each fitted at the bottom with a drop door of ordinary construction.

The wheels are 30 in. in diameter and are placed 3 ft. 5½ in. apart from centre to centre, the total wheel base being thus 10 ft. 3½ in. The axles are coupled in pairs by equalising beams connecting the axle-boxes as shown in the half sectional plan. The beams are fixed to the axle-boxes, and each is capable of turning on a centre as shown, the two axles of each pair thus being made capable of moving like the two parts of a parallel ruler. This arrangement gives, within certain limits, a flexibility equivalent to that afforded by the adoption of the double bogie system, but the axles are of course not capable of assuming a position radial to the curve traversed.

The springs are arranged over the centres of the beams coupling the axles; while the construction of the frames, which, as we have said, are of wood, is sufficiently clear from the engravings, as is also the arrangement of the brake. The wagons are fitted with the ordinary automatic combined central coupling and buffers in use in the United States. The weight of the wagons empty is from 4½ to 4¾ tons, and the maximum load carried is 10 tons. In conclusion, we should state that we are indebted to our contemporary the *Portefeuille Economique des Machines* for the particulars of the wagons we have described.

PHILADELPHIA AND READING RAILROAD.—Mr. William Loreas has been appointed chief engineer of this system in succession to Mr. C. E. Byers, deceased.

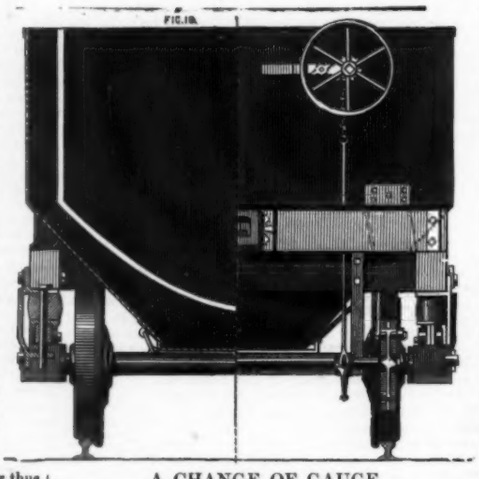


FIG 10.

A CHANGE OF GAUGE.

THE Philadelphia correspondent of the *Times* gives the following account of the change of the Ohio and Mississippi Railroad from a 6 ft. to a 4 ft. 9 in. gauge. He says:

"This change of gauge, to which I have already referred as having been accomplished on Sunday, July 23, is regarded as a remarkable feat of railroading. This line, connecting Cincinnati and St. Louis, 340 miles long, heretofore worked in the interest of the Erie, through the superior tact of one of their rivals was got out of Erie control. The new manager of its operations—the Baltimore and Ohio Railway—is a narrow gauge line, of 4 ft. 9 in., and consequently the gauge of the new auxiliary had to be reduced. The undertaking was one of great magnitude, involving not only the relaying of the entire line, but also a complete reconstruction of the locomotives and cars. For several months preparations were making for the work, and Sunday was selected for it, as on that day the line was least needed for traffic. The road was divided into 68 sections of 5 miles each, and an average force of 40 men detailed to each section—2720 men in all. At daylight they began their labours, each section gang being divided in two parties of 20 men each, who beginning at the extremities of their sections, worked towards each other, for the purpose of meeting in the middle, so that 2½ miles of line were changed by each party of 20 men. All the officers of the road were on the alert to bring the men at their work, and to expedite matters. The men laboured speedily and well; one section being completed by 7 a.m., all being done before noon, and the new road having been thoroughly tested by 4 p.m. The task was to move the rails inwards 7½ in. on each side, and spike them in their new places, and also a similar alteration of all the sidings and switches. As a preparation for this, in the course of two months of easy labour the new lines for the rails had been fixed on both sides by the driving into the ties of the inside spikes, under the tops of which the inside shank of the rail could be immediately fitted. The outside spikes were then driven; the inside ones fastened, and the chairs and fish-joints firmly spiked in their places. At many places, such as curves, where it was thought necessary to lay new rails, they had been laid in their places previously to Sunday, thus obviating the necessity of the immediate removal at those places of the old rails. Each gang worked systematically. The 'dentists,' two on each side, with their claw levers, led the van, jerking out the inside spikes, and thus loosening the rails of the broad gauge. The 'liners' followed, also two on each side, their business being to push the rails inward to the new narrow gauge line, and fix them properly in their places. The 'spikers' brought up the rear, firmly driving in the spikes. The workmen were paid 25 cents. an hour, and are commended for the energy and speed with which the task was performed; and large numbers of spectators are said to have flocked to the line at various places to see the unusual sight. Among those who took great interest in the work was a Catholic priest, Father Kline, whose flock are chiefly employed on the road, and who was present encouraging the labourers. He is said to have proposed a sentiment to the narrow gauge, 'for,' said he, 'it is the narrow road, you know, that leads to Heaven, and the broad one leads to—well, too far south.' To this the vice-president of the railway responded that the 'narrow gauge at least leads to the haven of financial security.' The priest drove in the first spike on one of the sections. The rolling stock also had to be completely changed, and 127 engines, and over 1900 cars adapted to the narrow gauge were procured. On Monday morning, the 24th of July, the new narrow gauge traffic began, and has been going on as successfully as if the road had not been so recently changed."

STEAM LINES FROM HAMBURG.—Hamburg is connected with other ports by 23 lines of steamers, of which only six are German. Ten are English.

EVANS'S VERTICAL MILL.

CONSTRUCTED BY MR. GEORGE PARSONS, ENGINEER, MARTOCK.

FIG. 1

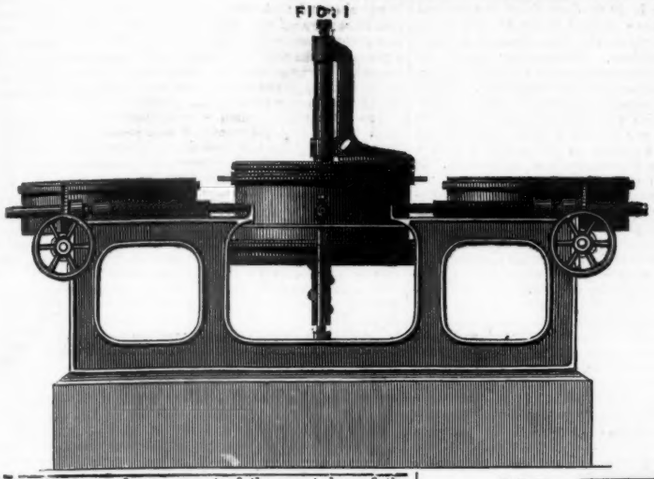
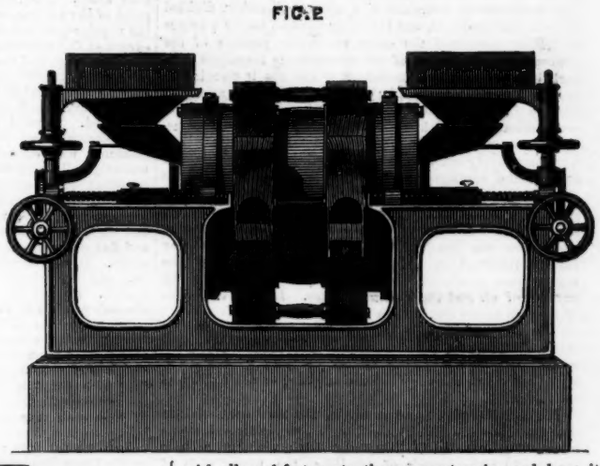


FIG. 2



In the course of our account of the recent show of the Royal Agricultural Society at Wolverhampton, we referred briefly to the mill with the stones arranged in a vertical plane, designed by Mr. Edward Evans, and exhibited by the maker, Mr. George Parsons, of Martock. In noticing this mill we stated that we intended shortly to illustrate it in the form in which it is now made, and this promise we now fulfil; Fig. 1, of the annexed engravings, showing the mill as arranged for dressing the stones, while Figs. 2 and 3 are respectively a side and end elevation showing the stones in regular working position.

By referring to these views, it will be seen that the peculiarity of Mr. Evans's plans consists in mounting three millstones vertically, the middle stone or "runner" rotating between two stones that are stationary. The two outer stones are mounted in gimbles, the grinding surfaces being dressed as usual. Motion is communicated to the runner, by means of a pulley on its periphery. The material to be ground is conveyed from the hoppers to the grinding surfaces by means of worms which rotate with the shaft and work within the eyes of the outer stones. The outer or stationary stones are supported laterally by means of screws which regulate the grinding and arrange them for "dressing." It is claimed for this mill, that owing to the position of the grinding surfaces being vertical, the grain or other material during the grinding process is acted upon much more freely than by the horizontal mill, the circulation is better, the grinding surfaces keep clear of fine or sticky particles, and the meal is dispersed from the stones all round, thus affording greater facility for the exhaust as it is not confined around the stone. The runner, which is keyed to the shaft like an ordinary pulley, is placed with its journals on smooth surfaces and balanced to stand in any position. By so doing, it can be driven at a high speed, and the stones impart less heat to the meal, as Mr. Evans states that the grinding is accomplished in a mere fraction of the time required in ordinary mills.

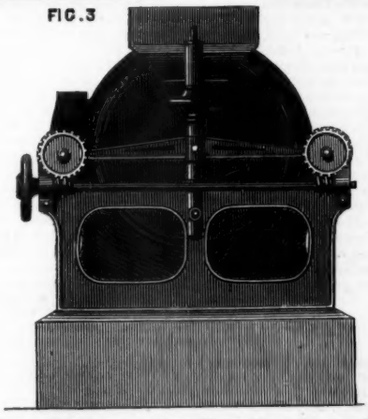
The grinding of such materials as ores, clay, coal, &c., is performed without the stones being in absolute contact, consequently, there is no danger of the surfaces being injured by running empty, or from scraps of iron. The reduction of the material in Mr. Evans's mill is accomplished by means of a combined percussive and triturating action, and the stones are capable of carrying a very heavy feed, owing to the fact of their being supported in their working position. It is also claimed as an advantage for this mill, that by using the runner as a pulley, and mounting it on the centre of a horizontal shaft, the power is applied directly. The strain of the belt is equal on the two journals, while, moreover, the shaft is free from torsion and its expansion cannot effect the grinding.

The stationary stones adjust themselves to the wear of the brasses or inequality of the surfaces of the runner, and having no rotary motion and being under the eye of the person in charge, their working condition is readily ascertained. The working parts are confined to the grinding surfaces and two journals; the latter are of ample size and length, and as when the mill is in full work the lateral pressure is relieved from them, they require but little attention.

By dispensing with the internal rotary balance and feeding through the stationary stones, there is nothing to get deranged or obstruct the feed when the mill is driven to a high speed. The mill can be driven from any position in a line with the pulley on the stone, and when mounted on travelling wheels for farm purposes, levelling is not necessary.

When the faces of the stones require dressing, they are placed in a horizontal position in the following manner: The feed arrangement and the casing, which is in two parts, being first removed, the middle stone is then raised from its bearings upon two trunnions which are inserted in two holes in a line with the diameter of the stone at opposite points, the bridge trees are then removed and the outer stones screwed back to the ends of the frame. These stones can then be turned into a horizontal position, and the worms removed ready to receive the tramstaff which is bored to fit the shaft, and placed on the spindle, as shown in Fig. 1.

FIG. 3



Without this instrument, the mill would not be complete, for by its means the faces of the stones are kept parallel, the surfaces true, and in "tram" with the shaft.

Altogether, we believe, as we have stated on former occasions, that there is much merit in Mr. Evans's plans, and we hope to see them fairly tested in practice. Very good results have, we may add, already been obtained.

NOTES FROM PARIS.

PARIS, August 14, 1871.

STEAM CULTIVATION.

STEAM cultivation is still but little practised in France, on account of the subdivision of landed property. But now a quite exceptional occasion has presented itself for the introduction of this branch of industry in the eastern departments. The English Society of Friends, actuated by those sentiments of charity and generosity of which England has given so many proofs to our country during her cruel trials, hastened, on the raising of the investment of Metz, to the assistance of the unfortunate Lorraine. They conveyed to the population ravaged by the armies of occupation, reduced by famine and by disease, help of all kinds—food, raiment, money. Agriculture has received a large part of their aid. Six thousand sacks of grain, of potatoes, of seed of all kinds, have been placed at the disposition of the cultivators of the Moselle. Not content with this aid, the Friends have also wished to supply the means of cultivation, which was rendered impossible by the want of horses and oxen; to purchase a complete system of Fowler's steam cultivators, to send it to Metz despite all the difficulties of transport now existing, to instal it, and to cultivate some 1200 acres in a few weeks; such is the brotherly work carried out without noise, without ostentation, and with a perseverance which has not slackened for an instant, by the English Aid Society for the French peasantry. The powerful cultivating plant, after it has done its work in the neighbourhood of Nancy and Pont-à-Mousson, will be sold at a reduced price to a society formed under the patronage of the Central Agricultural Society of the Meurthe. This society intends to work the system on the large extent of land suitable for its use, and proposes to make the engines advantageous for general purposes; already it has received a large number of orders for the cultivation of lands in the departments of the Meurthe and the Moselle. Thus, steam cultivation, which has hardly been employed till now in France, comes to enter into the science of practical agriculture; we wish all good fortune to the new enterprise, and hope it may serve as an example to be followed in other parts of the country.

BLASTING BY ELECTRICITY.

At the present time experiments on the ignition of blasts by electricity are being made in a mine in the basin of St. Etienne. The method, lately introduced from Germany, has for a short time been used in Belgium. It gives, it is said, good practical results, and the principal advantages found are that it effects simultaneous explosions, and suppresses the danger of misfires. The following is the mode of proceeding in sinking a shaft. The electric match is formed of two iron wires placed in a groove in a thin board, the length of which is a little in excess of that of the bore of the mine. These wires are joined at one extremity of the board in a capsule of tin, containing a fulminating charge, and which is placed towards the middle of the powder charge; the spark passes between the extremity of the wires, and causes the explosion. The charging and tamping require no special precaution. The wires of the electric match of different blasts are attached at their free ends to other wires, establishing between the matches a circuit, the extremities of which are attached to strong copper wires, insulated by a double wrapping of hemp and gutta-percha, and enclosed in an outer wrapping of twisted hemp, so as to make a single cable. This cable hangs constantly about 2 metres from the bottom of the shaft, and is payed out as the work gets deeper. The preparations are very simple, and are intrusted to the workmen; out of 4000 blasts only 20 misfires have been recorded. The electric machine is composed of a gutta-percha cylinder, rubbing on a cat-skin, and charging a condenser, which can be discharged at will. This simple machine costs only about 100 francs, the matches cost 10 centimes each, and the cable 1.40 francs per metre. Altogether, the process is simple and rapid, does not seem to involve much complication, and promises considerable advantages.

THE SUEZ CANAL.

M. Ferdinand de Lesseps, some months since, organised for the Suez Canal a service of "mareographes," intended for the investigation of the question, so long discussed, of the movements of the water in the canal. This service consists of 16 observers, who are placed in the following positions: at the entrance of the outer port of Port Said; the basin of Port Said; at kilometre 1 of the canal; at kilometre 34; at kilometre 54; at kilometre 69; at Lake Timsah; at Toussoum; at the entrance of the Bitter Lakes; at kilometre 133; at Chalouf; at kilometre 146; at the bac du piquet 72; at the ancien piquet 20; at the quarantine; at the level ground at Suez. From 6 in the morning till 6 in the evening, and each quarter of an hour, without interruption, they observe the heights of the water on the graduated standards placed for the purpose, the speed and the direction of the currents and the wind. The water of the Red Sea flows slowly towards the Mediterranean, with a slightly varying speed, resulting from the alternating and unequal rate of the tides in the seas. It is a river of marine water traversing the sea of sand which stretches from Egypt to Arabia Petrea. By the established arrangements all the movements of the water can be determined with great precision, and the results will doubtless be full of interest, for, until now, it has of course been impossible to observe the hydrodynamical phenomena presented by a canal of so great a length and uniformity of level.

THE PONSARD FURNACE.

M. Ponsard is the inventor of a system of furnace analogous in some respects to the Siemens system, but which it is claimed, effects in a more simple manner the regeneration of the heat. The fuel is transformed into gas in a

generator, and this gas is drawn by the uptake into the furnace proper. The necessary air for the combustion of the gas arrives in the furnace after having been heated in the regenerator, and the gases resulting from combustion escape by the uptake after traversing the regenerator. This apparatus is composed of a cubical chamber, divided into vertical channels, one set being devoted to the passage of the hot gases, and the other set to the passage of the atmospheric air. Each of the chambers is furnished with partitions to check the movement of the gas it circulates; the partitions, constructed in perforated brick, and arranged lozenge fashion, establish between the various chambers communications which also increase the heating surface. By this arrangement the apparatus possesses great power in a comparatively small volume. It will be seen that in this furnace the arrangements applied to the air and to the gases of combustion differ from the Siemens system, and it is claimed that it involves a less amount of complication. Less attention is required in the working of the furnace, and there are less valves to manipulate. The flame can be rendered at will, oxidising or reducing, or the temperature produced can be varied by regulating the current of air and the current of gas. Lastly, this class of furnace is less costly than that of the Siemens.

The Ponsard furnace is applicable to various metallurgical operations, to the fusion of metals, the manufacture of cast iron, to that of steel, to the puddling of cast iron, to re-heating, to the manufacture of glass, or the baking of ceramic work.

We may describe, as an example, the treatment of iron ores as followed by M. Ponsard in his experimental shops in the Avenue Suffren. The furnace is reverberatory, it is traversed by two groups of crucibles, the upper ends of which are open to the free air, and their lower ends rest on banquettes on each side of the furnace. The ore, suitably broken and mixed with flux and carbon necessary for reaction, is charged into the crucibles; under the action of the high temperature of the furnace the mixture is rapidly heated, the oxygen of the ore is disengaged, the reduction operates, and the carbonation as well as the fusion of the metal takes place in the same manner as in a high furnace. As the ore is reduced, and the charge sinks in the crucible, new supplies are added, so as to obtain a continuous fusion. The crucible and the parts of the furnace exposed to the high temperatures are of carbon and silica. M. Ponsard has worked specially upon the question of refractory products, and with the help of M. Meiller, maker of pottery at Ivry, he has made the arches and hearth of his furnace to resist for a protracted period the intense heat produced by the employment of the regenerator. The inventor produces steel by his process, and during the siege he conducted some interesting trials for obtaining a metal suited for the manufacture of heavy guns and chassepôt barrels. The process, already in course of application in different works, is at present the object of close investigation on the part of several metallurgists, and a company has been formed for the working of the processes and their industrial application.

THE GREAT WESTERN RAILWAY, N.S.W.

On page 88 of our last volume we described the general works upon the Great Western Railway of New South Wales, which have been so successfully carried out by the engineer, Mr. Whitton. The line commences at Sydney, and runs northwards through the Lowlands, across easy country till it leaves Paramatta, and crosses the river Nepean by a stone bridge 600 ft. long. The mountain section commences at a short distance from this point, and, after passing the Emu ranges, the foot of the first Zigzag of the Blue Mountain is reached. This range forms a chain of lofty and rugged mountains, consisting of sandstone escarpments, with dark chasms and gloomy ravines. The portion of the great dividing chain, generally known by this name, is very limited in extent, but in reality it includes all the mountainous tract stretching from the Liverpool ranges to Lake Burra Burra, south of the thirty-fourth parallel. Near the commencement, the range is not high, being lower probably than any other part of the dividing chain. Its course, generally southerly, is very irregular, and, though 150 miles from the sea at starting, its average distance is not more than seventy miles. In the middle of their course the Blue Mountains consist of two ranges, running nearly parallel, and separated by a deep narrow valley. The western exceeds the eastern in altitude, and the mountains rise into distinct peaks and summits. Owing, probably, to the fact of these mountains being composed, on their eastern face at least, of sandstone rock, they present more the appearance of a table land, having few elevations rising much above the general level. Even these are for the most part rounded in form, instead of being serrated, or rising into pointed peaks, as occurs in mountains composed of older rocks. But the surface of the Blue Mountains is scored with vast chasms and deep ravines, with precipitous walls of rocks on each side. Narrow, gloomy, and profound, these stupendous rents in the bosom of the earth are enclosed between gigantic walls of sandstone and rock, sometimes receding from, sometimes overhanging the dark bed of the ravine and its black silent pools, or its foaming torrents of water. Many of the precipitous sides of these ravines have a depth of 1500 ft. The average height of this portion of the dividing chain is about 3300 ft., though some of the peaks attain a somewhat higher elevation—the highest being Beemarang, 4100 ft., at the head of Campbell's river.

Such is the character of the country where the Zigzag is situated. The course of the gully down which the railway line is thus brought, is about E.S.E. to W.N.W.

The descent from the Mount Clarence range into the Lithgow Valley commences by a long cutting from which about 45,000 yards of excavation have been taken. The greater part of the rock cut through is hard blue stone; but a vein of whitish stone was found running through a great portion of it, which turned out to be much harder than the blue stone. The cutting is 40 ft. deep from the highest point of the surface, and has a descent of 1 in 42, that being the regular gradient throughout the three lines of descent, except at the reversing stations. After passing one or two small cuttings and embankments, we come to No. 6 cutting, from which 15,000 yards of excavation were taken. These, with an additional 40,000 obtained elsewhere, went to make up the 55,000 yards of which the adjoining embankment is composed. Beyond this are several smaller cuttings and embankments, and then we reach an embankment with a retaining wall containing 20,000 yards of excavation. It was originally proposed to have a viaduct here, but on reconsideration an embankment with a retaining wall was substituted. It is very solidly built, the space behind the retaining wall being closely packed with stone. The stone used in this wall, as well as in the culverts and viaducts, is very hard and fine grained, as has been mentioned, and is also perfectly white. It was obtained from a quarry about half a mile from the line, opened specially for the purpose by the contractor. Beyond this embankment the formation for a short distance consists of light earthworks, until another embankment, containing 12,000 yards of earth is reached, and then through a rather large cutting we come to No. 2 viaduct. This is built upon a curve of 10 chains radius, and has seven arches, five of 30 ft., and two of 15 ft. span. From this viaduct to the first reversing station there is one continuous cutting through the solid rock, and from it over 100,000 yards of excavation have been taken, the face of it, in one place, being no less than 50 ft. deep. A large proportion of this excavation has been used to make an extensive embankment on the lower line, and in order to get it down without carrying it along the Zigzag, leading it and tipping it, a shaft 120 ft. was sunk, and a tunnel put in from below to meet it at the required level. By this means the excavation material was shot down, and taken thence to the point for which it was required. Between the points and the end of the reversing station the gradient is 1 in 66, but in all other parts of the descent, except the corresponding portion of the second reversing station, the gradient on the Zigzag is, as above stated, 1 in 42. Beyond the points, and close to the reversing station, there is a short gap where the rock is considerably below the rail level. This has been spanned over by an arch, bringing the line compactly up to the reversing station.

The descent of the middle line is now commenced, and at the outset it crosses No. 3 viaduct. This is 330 ft. in length, and consists of nine arches of 30 ft. span. The height of these arches give them a very fine appearance, the distance from the ground to the rail level being 76 ft. The line being cut in the sides of a cliff bluff and precipitous as we have described above, it became necessary to construct viaducts in those places where the rock did not project sufficiently to bear the line. Thus, in the present instance, a break in the face of the rock, caused by a small stream of water which has forced itself away in this direction, rendered this viaduct necessary. Some of the difficulties in the way of the contractor may be mentioned: first, there was scarcely enough shelf on the rock outside the intended structure to rest the bottoms of the scaffolding poles on which the travelling crane had to be erected. Then all the stones used in the work had to be lowered over the cliff from the top line; and men had to go down over the cliff, returning by means of steps cut in the face of the rock, and holding a rope to secure them from falling. In the face of such difficulties it is surprising that there were so few accidents, and that these few should have been of so comparatively a light character. From this viaduct the line passes over a short piece of cutting where the rock stood which was blown away by the first great blast in January, 1867, and then comes on to No. 4 viaduct. This has eight arches of 30 ft. span, and is 300 ft. in length, and is built on a curve of 10 chains radius. The two next cuttings which are passed are large, having had no fewer than 46,000 yards of excavation taken out of them. Next follows a large embankment, reaching down to the lower line, and containing some 30,000 yards of excavation; and beyond this is a cutting 42 ft. deep, through the solid rock, from which 25,000 yards of excavation has been taken. Passing over an embankment of 18,000 yards of excavation, the line reaches No. 1 tunnel, which is cut through a spur of the rock on a curve of eight chains radius. This tunnel is 75 yards in length, and is lined with masonry of very superior workmanship. Being on a curve, the effect of the very beautiful work that has been put into the tunnel is striking in the extreme, and is the subject of remark by travellers. In fact, the whole of the mason's work on the Zigzag is of the very best description. Beyond the tunnel there is an embankment containing 15,000 yards, and immediately afterwards the site of the last great blast is reached. At this spot it was intended to have a tunnel, but after it had been excavated doubts were entertained as to the stability of the rock, as it was found to contain deep fissures, through which sand, &c., was continually running. It was also found that a large portion of this rock rested upon a bed of pipeclay and shale, which only required the inlet of water to cause the overhanging mass to slip away. Under these circumstances, to avoid the possibility of an accident, Mr. Whitton, the engineer-in-chief, determined to have the rock removed. The removal of the whole of the block at one explosion would, of course, effect an immense saving in time, labour, and consequent expense; and preparations were commenced for the great blast. In the first instance, three chambers were cut in the face of the rock, inside the tunnel, one 32 ft., one 27 ft., and one 22 ft., and then others at right angles, giving them the form of the capital letter T; and in these chambers, which were on a level with the floor of the tunnel, were deposited 2 tons of powder. The battery by which the whole of the powder was fired was composed of 58 cells. All the wires terminated in a fuse, composed of copper and zinc, which was enclosed in a small circular deal box, and deposited in the centre of each charge of powder. The wires were then attached to two other wires that were connected with a switch, or circuit closer, placed about a hundred yards from the rock to be removed. As soon as the dust from the explosion cleared away a little it was observed that the explosion had caused a wide deep rent in the top of the mass of rock which had thus become in a great measure detached from the cliff, and inasmuch as a portion of the rock lower down and outside was seen to be crumbling away at the enormous weight of rock above, the entire mass appeared to require but a push and the whole would tumble over into the valley below.

The same reason which necessitated the removal of the mass in the first instance had now prevented the powder from exercising the full force which it would have exhibited upon a solid rock; that is to say, a portion of the force of the powder had escaped through the fissures in the rock. The entire block was now completely shattered, and a few seconds after the blast was fired the roof of the tunnel fell in. A careful inspection afterwards proved that the execution had been far greater than at first sight appeared, and a few men, using occasionally a small charge of powder, very shortly tumbled over a large portion of the rock.

Now that the work is completed, it presents the appearance of an enormous cutting, of which the face is 110 ft. deep. The next cutting is also an immense piece of work, being 80 ft. in height on the face of the rock, and having had 50,000 yards of excavation removed from it. This brings the line down to the second reversing station, where an immense quantity of the face of the cliff, much of which had been overhanging, has been cut away, and being placed on the formation level of the line, has formed a fine wide platform, giving abundance of room for shunting, siding, &c.

The descent of the lower line begins with two small embankments, and then follows a cutting in the face of the rock to a great height to allow sufficient width for the line. An embankment containing 26,000 yards follows, and then comes a large cutting, where the rock to 120 ft. has been taken down to prevent accident to the line. Something like 40,000 yards have been taken out of this. Several smaller cuttings and embankments succeed, and then come two large embankments which contain the large quantity of 120,000 yards of excavation. This brings the line to the end of the Zigzag, being immediately under the first reversing station. From the one point to the other a descent of 265 ft. has been gained, whilst the depth gained from the commencement of No. 5 contract, only a few chains beyond the point first mentioned as beginning the descent of the Zigzag, is 500 ft. The length in which this descent has been gained is three miles and sixty chains, although as the crow flies it is only one mile and a half.

The illustration on page 108 conveys a very correct idea of this remarkable and successful work, which has deservedly brought so much credit upon its constructive engineer. The facts contained in the foregoing article we have taken from different New South Wales' journals.

EXPLOSIVE AGENTS.

*On recent Investigations and Applications of Explosive Agents.**

By F. A. ABEL, F.R.S., Treas. C.S.

THE paper submitted by Mr. Abel to the British Association embodies an account of the recent progress made in the production and application of explosive agents. Although a very long and elaborate paper, the author modestly disclaims anything more than an attempt to give an outline of the nature and results of the important investigations which have been instituted, and are still being pursued, relative to the development and regulation of the explosive force of gunpowder, and the application of some other explosive materials. The paper itself contains a large amount of information, much of which having already appeared from time to time in our columns, renders it unnecessary to do more than place a full abstract of Mr. Abel's paper before our readers.

The author first directs attention to gunpowder, briefly noticing its manufacture, and the causes which operated in demanding a reduction of the violence of its action. So long ago as 1858 a committee was formed for deciding upon the best powder for the Enfield rifle, and they were afterwards directed to investigate the question of cannon powder with a view to modifying its violence. This led in 1860 to the introduction of the rifle large grain powder, and subsequently in 1864 to the use of pellet powder. The principles laid down by the first committee on gunpowder in 1858 as their guide in attempting to reduce the violence of the action of that material when fired in large charges were based upon mechanical considerations, and have been adhered to ever since. As gunpowder is simply an intimate mechanical mixture of a powerful oxidising agent, saltpetre or potassium nitrate, with two readily oxidisable substances, sulphur and carbon or charcoal, the behaviour of the mixture, and the nature of the results furnished by its explosion are susceptible of great modification by variations in the proportions of its ingredients. In fact the explosive action of gunpowder is susceptible of very extensive modification by variations of its composition. There are, however, certain proportions which appear best as furnishing the largest amount of gaseous matter compatible with the development of the highest temperature. This is independent of other considerations affecting the question.

It was upon considerations relating to the chemical action of the ingredients of gunpowder that the committee came to the conclusion that in attempting to moderate its violence, when used in large charges, it was unadvisable to make any change in its established composition which might be productive of a diminution of the total pressure developed by a charge unless the desired results were unattainable by modifying its mechanical and physical powers. In other words they were desirous of effecting their object by introducing changes in the preparation of gunpowder and in the form in which it is employed. A very few experiments

* Paper read before Section G of the British Association.

served to demonstrate that [the rapidity of explosion of gunpowder was readily susceptible of great reduction by simple mechanical means. These means have, therefore, been adhered to by the present committee on explosives in developing the powder now used for heavy guns. There are five different points affecting the modification of gunpowder, and these are, the size of the grains, their form, the mechanical condition of their exterior, their density and their hardness. The first promising results obtained were arrived at by simply increasing the size of the grains. Subsequently it was found that these results were still further improved by paying attention to the density and hardness of the powder and by promoting the uniformity of these properties.

A vast number of experiments have been made by various investigators into the nature of the action of fine gunpowder from the beginning of last century, when M. de la Hire took up the question down to the present day. These experiments include those made by Robins, by Count Rumford, by Colonel Caralli, by Major Rodman in the United States, by Captain Noble in England, and by various committees both at home and abroad. The methods adopted by the experimenters, as well as the results attained by them are given by Mr. Abel, who describes at some length the ingenious chronoscope devised by Captain Noble. A comparison of the results of experiments made by means of the chronoscope and a 10-inch gun with R. L. G. powder, with the Russian prismatic powder, and with pebble powder demonstrate the superiority of the latter. By employing pellet or pebble powder as now manufactured not only is the strain upon the guns up to those of 25 tons greatly reduced when velocities equal to those furnished by the R. L. G. powder are attained, but considerably increased effects are obtained from these guns without submitting them to a greater strain than they would be exposed to in employing the former service powder to obtain the standard results. In dealing with the 35-ton gun, however, the author refers to the unsatisfactory results afforded by the new powders, and observes that further modifications in their manufacture will possibly have to be introduced to meet the requirements of the case. The subject is now receiving careful attention in several quarters, and Captain Noble is pursuing a special line of investigation with reference thereto.

Captain Noble's experiments promise to throw important additional light upon the nature of gunpowder as a propelling agent. They consist in exploding powder in close chambers on the plan adopted by previous experimenters with modifications afforded by the advanced state of science. The conclusions arrived at by Count Rumford and by Major Rodman as regards the pressure exerted by gunpowder differ greatly from each other, as well as from the conclusions arrived at by Bunsen and Schischkoff in 1857. The heat developed was by these latter experimenters estimated at 5080° Fahr., and the pressure at 4874 atmospheres, or about 29 tons per square inch. But recent experiments made by Berthelot during the recent memorable siege of Paris appear to have shown that Bunsen and Schischkoff's estimate of the pressure of fired gunpowder is too low, just as Piobert's, which fixes it at 9600 atmospheres or 64 tons, is considered too high. Some experiments made by Karolyi, in which he exploded small charges under conditions more nearly approximating to those of the actual employment of gunpowder, furnish results not greatly at variance with those of Bunsen and Schischkoff. The value to be attached to them, however, appears likely to be definitely determined before long by the experiments upon which Captain Noble is at present engaged. In iron vessels of great strength he explodes by electric agency charges of gunpowder ranging up to 2 lb. The space in which the charges are fired is varied from that entirely filled by the powder to that in which the latter occupies only ten per cent. of the space. The vessel is fitted with a crusher gauge, by which the maximum pressure developed by the explosion is recorded. The gases are in all instances entirely confined and are allowed to escape gradually, as soon as expedient after the explosion, with a view to the measurement of their volume, and the collection of portions for analysis. The examination of the gaseous and solid products has been undertaken by Mr. Abel, who observes that it would at present be premature to refer to the results obtained so far. He states, however, that the maximum pressure of fired gunpowder, unrelieved by expansion, has been found to be about 40 tons per square inch. The tension and density of the gases from powder fired in a close chamber are found to be very similar to those of powder burned in the bores of guns.

Passing on to the consideration of the substitution of other explosive agents for gunpowder, Mr. Abel observes that for small arms and artillery, no rival has yet established any good claims to success as a propelling agent. He first notices gun-cotton which he does not think will ultimately prove useful for larger artillery than field guns, although he does not predict even this application. White gunpowder and other chlorate mixtures are noticed and their danger in mining operations pointed out. The application of these violent explosives to shells are then referred to, and the experiments for ascertaining their relative susceptibility to explosion are described. These experiments consisted in placing definite quantities of the materials between flat brass plates, placing them upon a rigid support and allowing weights to fall upon them from different heights. By varying the weight employed and the surface and thickness of the layer of explosive material operated upon some interesting and probably useful results are obtained. These experiments are now being carried out and will be reported in due course by Mr. Abel. Nitro-glycerine in the form of dynamite has been tried at Shoeburyness for shells, but a want of confidence in nitro-glycerine preparations, and the excess of explosive power they possess has led to a search for some other explosive for shell charges. This has been discovered by Mr. Abel in one of the salts of trinitro-phenic acid or picric acid, which, from experiments recently made at Shoeburyness, and recorded by us at the time, appears likely to be introduced into the service as a material for shell charges.

Mr. Abel next notices lithofracteur as a destructive agent, referring to its use by the Prussians during the recent war. He then touches upon dynamite, which was used by the French also during the war. The author then refers back to gun-cotton and to the experiments that have been made with it, and the improvements which have been made in it since the British Association meeting in 1862. The chief improvement, and that which has placed it much more under control than it formerly was, is Mr. Abel's pulping process, supplemented by compression by hydraulic power. The safety from accidental explosion and the power of this substance, together with the method adopted in firing it with a detonating fuse are then successively dealt with by Mr. Abel, who finally details the various practical experiments which have been made from time to time in the demolition of stockades and other military structures, and which demonstrate the applicability of compressed gun-cotton to such purposes. Mr. Abel's paper shows that the production and utilisation of these powerful agents of destruction and these indispensable auxiliaries in the development of industrial resources have been advanced in an unprecedented manner within the last few years. It further renders it clear that much remains to be learned regarding their nature and operation, and the conditions to be fulfilled in their most efficient application in many important directions.

FOREIGN AND COLONIAL NOTES.

Bombay, Baroda, and Central India Railway.—The Indian Government has sanctioned the erection of an ornamental station for the Bombay, Baroda, and Central India Railway at Bombay. The site selected is on the esplanade opposite the Frere fountain.

New Zealand Lignite.—A valuable seam of lignite has been discovered on Moa Flat in the province of Otago, New Zealand. Its extent is at present only a matter of surmise, but, judging from appearances, it is considerable. A co-operative society has been formed by a number of residents to work the seam in an economical manner, so as to limit the price to 15s. per ton, cartage included.

A Bridge for the Hooghly.—An act for the construction of a bridge across the Hooghly between Howrah and Calcutta is published in the *Calcutta Gazette*. The Lieutenant-Governor of Bengal will have power to levy on the bridge a fee of two pies on every manuet of goods, and two pies on every passenger, with the option of lowering the toll if desirable. His honour will appoint toll-keepers, determine the bye-laws, &c., and will advance for the construction of the bridge such sums bearing an interest of 4½ per cent. per annum, as are sanctioned by the Governor-General of India in Council.

Railroads in the State of New York.—A report of the New York State Engineer of Railroads states that the number of roads operated by steam in the State is 164. The amount of the capital stock paid in is 234,225,159 dols. The length of the steam roads in the State is 7166 miles. The number of first-class passenger cars in use upon the roads was 1229; and the number of freight cars was 34,051. The total earnings of the roads operated by steam in the State amounted last year to 69,549,444 dols.

Victoria Water Works.—Colonel Sankey has been continuing his examination of the Government water works of Victoria. Some temporary repairs to the tunnel of the Malmsbury reservoir have been completed. Brick shields have been constructed for the purpose of preventing an influx of water at the retaining wall, and also at a point where the basalt formation joins schist. Men also have been engaged in placing the bye-washes in a thorough state of repair, so that when the valves are lowered over the inlet pipe the surplus water may escape without injuring the works. Permanent repairs to the outlet works are not to be proceeded with for the present.

Railways in New South Wales.—It is understood that the three leading railway lines in New South Wales—the Northern, the Southern, and the Western—are about to be extended at a further cost of 1,000,000*l*. The capital will be raised as hitherto in the London money market by means of New South Wales Government debentures.

Darien Exploration.—The Darien exploring expedition of the United States has concluded its labours for the season, and the result has been to dispel the illusions so long entertained as to the existence of a practicable route for a canal to unite the two oceans between the whole course of the Atrato and any part of the Pacific coast. The American Government seems determined, however, to persevere still further in the matter.

The Belgian Iron Trade.—Official returns show that the whole exports of iron from Belgium in May amounted to 22,920 tons. The aggregate exports in the five months ending May 31 this year were 79,884 tons, against 106,267 tons in the corresponding period of 1870.

Indian Railway Traffic.—The traffic receipts of the Indian lines amounted, in the first three months of this year, to 1,653,568*l*., acquired with 4975 miles in operation. The corresponding receipts in the corresponding period of 1870 were 1,710,606*l*., acquired with 4449 miles in operation. The results disclosed by this year's figures will be seen to be not very favourable.

Commerce of New Orleans.—The value of the exports from New Orleans during the year ending June 30, 1871, amounted to 95,246,791 dollars. The domestic produce exported was valued at 93,953,081 dollars, and the foreign produce re-exported at 1,293,710 dollars.

Victorian Water Supply.—Colonel Sankey is to report upon the whole question of Victorian water supply. Mr. Dobson, who was acting engineer of the Melbourne and Hobson's Bay Railway during the absence of Mr. Eladon, has been appointed an engineer in the Victorian water department, and is accompanying Colonel Sankey on his visits of inspection.

Railways and Telegraphs in Buenos Ayres.—The advices from Buenos Ayres reach to the 5th of July. The Session of the Argentine Congress had been opened by a Message from President Sarmiento, which gave a concise review of the progress of the Republic, and announced that it was now throughout its vast extent in the enjoyment of perfect peace. The railway system had been considerably extended, 531 miles being open, while 424 were in course of construction and 1954 were being surveyed, or had already been surveyed, the line from Cordova to Tucuman being among the latter. Of telegraph lines, 1228 miles are at work and 2630 more will be laid during the ensuing year.

Water Gauges for the Mississippi.—Water gauges to measure the flow of the Mississippi and its principal tributaries are to be established at Carrolton, Baton Rouge, Red River Landing, Vicksburg, Providence, Napoleon, Helena, Memphis, Cairo, St. Louis, and Rock Island. Gauges are also to be constructed at Alexandria, on the Red River; Little Rock, on the Arkansas river; Jacksonport, on the White river; Florence, on the Tennessee river; Louisville, on the Ohio; and Leavenworth, on the Missouri. A sum of 5000 dols. was appropriated for this purpose by congress in its last session.

Railways in New Zealand.—The tender of Messrs. Hayter and Co. has been accepted for a small extension of the Northern Railway of the Province of Canterbury, New Zealand. The provincial government of Nelson, New Zealand, is willing to sanction the construction of a railway from Nelson to Fox Hill, a distance of 22 miles, and another line from the Brunner coal mine to either the port of Greymouth or Cobden, as shall be decided by Dr. Hector and Mr. Blackett.

THE RANSOME PATENT STONE COMPANY.—We notice that the long-established and most flourishing company for the manufacture of artificial stone under the various patents of Mr. Frederick Ransome has slightly modified its title with the object of expressing in a more precise manner the actual functions of the company; at the same time, its rapidly increasing business necessitates a considerable extension of the manufacturing premises, and certain alterations in directorship and management have been made. We are pleased to see that Mr. Henry Bessemer acts as chairman, and that amongst the directorate are such men as Mr Bryan Donkin, Mr. Edward Woods, Mr. Frederick Ransome, and Mr. J. R. F. Burnett. We believe that while the original shareholders retain their relations with the company unaltered, a certain amount of fresh stock is allotted for the expenses connected with the enlargements. It is scarcely necessary to point out that the success which has hitherto attended these works must necessarily become even more decided, when extended means for carrying out orders under Mr. Ransome's recent improvements are provided. We believe that the manager of the works is Mr. A. Pye Smith.

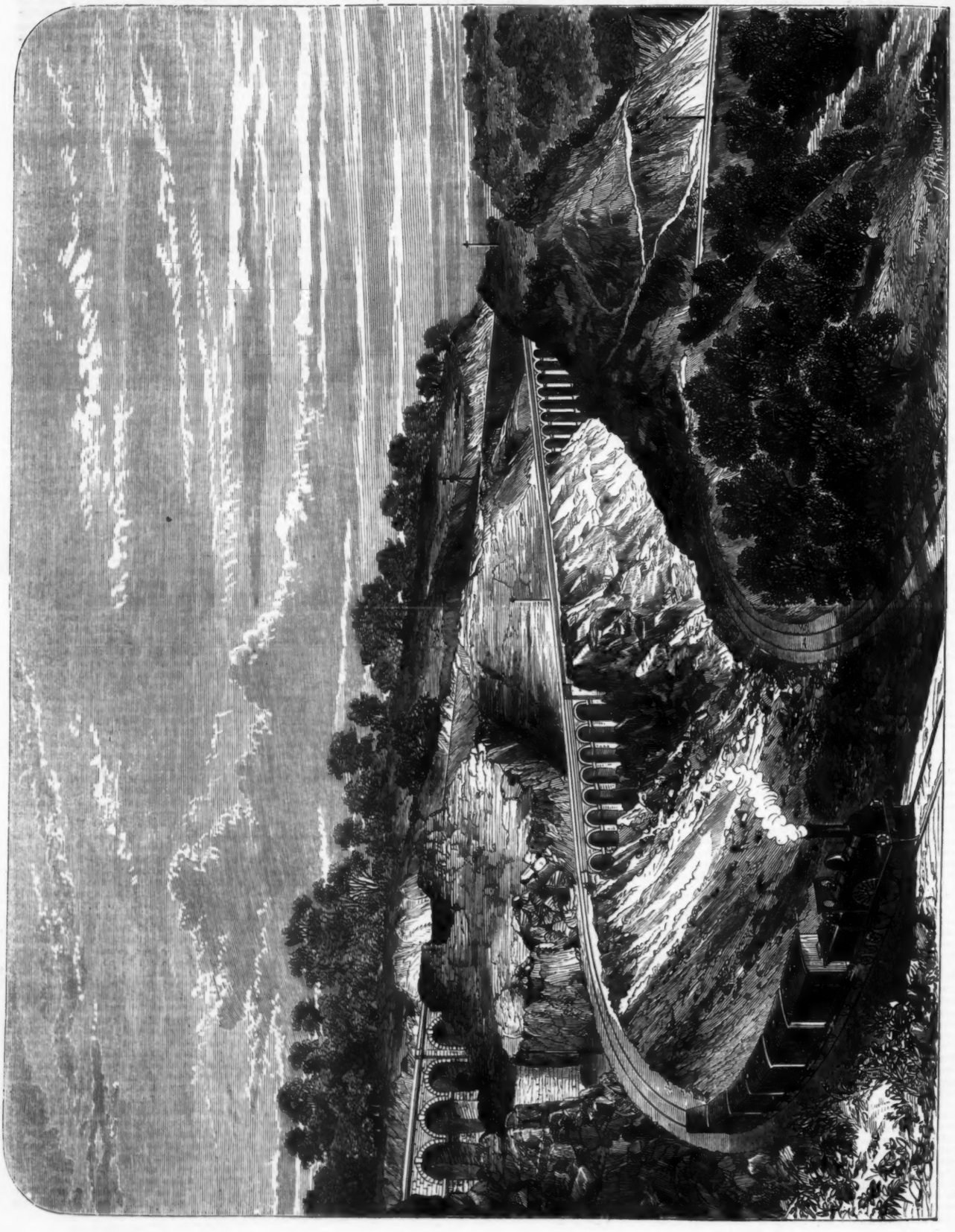
LONDON RAILWAY COMMUNICATION.—A scene illustrative of the management of the Metropolitan District Railway occurred between 11 o'clock on Sunday and 1 o'clock Monday morning. The train which came into Praed-street, Paddington, and was travelling towards Victoria, was thronged with passengers, all classes being intermingled, and in first, second, and third classes all sorts and conditions of people were crammed together. The platform was filled with persons anxious to travel, and the train moved away with every inch of standing-room occupied in every class, and even then left some on the platform. The train lightened a little before it got to South Kensington, where every passenger was made to descend and wait. A second train came in about midnight, and the passengers were for a time overwhelmed by the rush for seats made by the bitterly indignant throng on the platform; but all were made to descend, the guard instructing the porters to "get 'em all out," and this train moved away. The train for Westminster did not come in for some time after, and it was half an hour after midnight when the train reached Westminster, the time occupied by passengers getting from Paddington to the Houses of Parliament being no less than an hour and a half.

ENFIELD RIFLE FACTORY.—Mr. James Nasmyth has written a sensible letter to the *Times*, directing attention to the folly of the proposed removal of Lieutenant-Colonel Dixon from the management of the Enfield Rifle Factory. Mr. Nasmyth says: "Long experience at the head of a large manufacturing establishment, and frequent visits to Enfield Rifle Factory, justify me in stating that a more perfectly arranged and effective establishment does not exist, either under private management or Government control. Enfield Rifle Factory is, in short, a perfect model of organisation, arrangement, and efficiency, and is the admiration of all who are specially qualified to judge and express an opinion on such a subject. To such there can be no doubt as to the source of the admirable results which issue from this establishment. It is to the high order of intelligence and untiring zeal of the superintendent officer, Lieutenant-Colonel Dixon, who has been at the head of this establishment for upwards of sixteen years, that we are indebted for the excellent results that have uniformly issued from Enfield Rifle Factory. If ever there was a case of 'the right man in the right place,' this is one. What, then, will the public think of the wisdom of our War Department, who have, in the very zenith of Lieutenant-Colonel Dixon's accumulated experience and efficiency, served him with notice to retire from his superintendentship of Enfield Rifle Factory on the 1st of April next, in order, as I am informed, that the vicious and insane system of short periods of service, or frequent removal of the superintendent officers, which has worked such incalculable mischief to the public interests in our dockyards and arsenals, &c., shall be henceforth applied to Enfield Rifle Factory? I have not words at command to adequately express what I think of such a proposal. The result will be disastrous to this, one of the most important of our Government establishments, and consequently to the interests of the nation at large."

THE GREAT WESTERN RAILWAY OF NEW SOUTH WALES: THE BLUE MOUNTAINS ZIGZAG.

MR. WHITTON, ENGINEER.

(*For Description, see Page* 106.)



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CONTENTS.

	PAGE		PAGE
Literature	99	Explosive Agents	106
Mechanical Refinements	100	Foreign and Colonial Notes	107
Shaft Sinking through Water-bearing Sand, near Homberg	101	Road Steamers	109
Railway Gauges	102	Indian Railways	110
The Patent Laws	103	The Stowmarket Explosion	111
The Loss of the Captain	103	"Section G"	111
The Great Eastern Dry Dock, Milford	103	The "Waterstaat" of Holland	112
Indian Engineering Examination	103	New Overland Route to India	112
Coal Wagons on the Baltimore and Ohio Railway, U.S.A.	104	Notes from Cleveland and the Northern Counties	114
A Change of Gauge	104	Notes from the South-West	115
Evans's Vertical Mill	105	Notes from the North	115
Notes from Paris	105	Recent Patents	116
The Great Western Railway, N.S.W.	106	Steam Boiler Legislation	116
		On an Automatic Discharge Gauge	116
		Private Bills in Parliament	116

ENGINEERING.

FRIDAY, AUGUST 18, 1871.

ROAD STEAMERS.

THOSE of our readers who were present at the recent trials of agricultural locomotives at Wolverhampton, or who paid attention to the results which we recorded at the time, must, we fancy, have read with considerable surprise the paper on "Road Steamers" by Mr. R. W. Thomson, contributed to Section G of the British Association, and published by us in our last number. It was no doubt natural that Mr. Thomson should favour the Association with a paper on his road steamer when he had an opportunity of doing so, and it is, perhaps, equally natural that he should regard the performances of those steamers with a somewhat partial eye: but we can nevertheless only account for that portion of his paper referring to the Wolverhampton trials ever having been written, by remembering the fact that Mr. Thomson himself was not present at those trials, and by supposing that he failed to make himself thoroughly acquainted with their results. We printed Mr. Thomson's paper because we desired that he should have the opportunity of expressing his opinions fully in our pages; but having done this it would be unjust to the competing firms at Wolverhampton, and also to ourselves, if we allowed the statements made in that paper to pass unnoticed.

Of the earlier portion of Mr. Thomson's paper we have no occasion to speak, neither need we do more than refer briefly to his statement that the adhesion of rigid wheels on smooth-paved streets "is so little as to be practically valueless"—although we believe that the inhabitants of Rochester might give him a little useful information on this point; but we may direct attention to the information he offers that "india-rubber tyres, on the contrary, maintain a singularly uniform degree of hold upon the road, whatever may be the nature of the surface;" and that "the only kinds of soil on which the india-rubber tyres cannot work are ground so soft as to flow away under the wheel, or wet clay, which has a tendency to ball upon the wheels and so impede the action of the india-rubber." Readers of this latter quotation may perhaps be inclined to remark that the conditions which are, let us say, "awkward" for india-rubber tyres are not excessively dissimilar to those which cause trouble to rigid wheels; but of this we shall say more presently; our immediate object is to speak of Mr. Thomson's remarks on the Wolverhampton trials.

Mr. Thomson's first remarks on these tests refer to the preliminary run made by the competing engines over the course at Barnhurst, without loads behind them. The results of this run Mr. Thomson sums up in the words: "The quickest road steamer went round in 15 minutes; the quickest traction engine in 23 minutes." Now this, although approximately true, is not by any means the whole truth. The facts are that the quickest road steamer (Burrell's) with india-rubber tyres went round the course in 15½ minutes, and the quickest traction engine with rigid wheels in 22½ minutes; while the second fastest traction engine did the distance in 22¾ minutes, and the second road steamer in 24½ minutes on the first trip, and 23½ minutes on the second. These facts, however, are after all of no practical value, as, except on the part of the road steamers, no effort was made to race round the course by the engines entered for competition. Any of the rigid-wheeled engines could have been run round at a higher speed had their owners considered it necessary to attain such a speed, and it may be further mentioned that one of Messrs. Fowler's 6-horse engines with rigid wheels, not entered for competition, was actually run over the course in 16½ minutes, notwithstanding that for a great portion of the distance it was delayed by the presence in front of it of a slow moving engine.

Of far greater importance, however, are Mr. Thomson's assertions respecting the performance of the engines when drawing loads. Stating correctly that the first engine to go over the course was a traction engine with rigid wheels, and that this engine was followed by the road steamer "Sutherland," he goes on to say when this latter engine "came to the great holes in the ground dug by the spudded engine, it had very great difficulty, owing to the wet greasy nature of the soil, in getting through them; and, by-and-bye, when the state of things was rendered even worse by a thunderstorm which converted the ground into a swamp, it had to throw off its load, and only with great difficulty, and after several hours, succeeded in completing its round." Now, we cannot but regard this as a most disingenuous account of the failure of the "Sutherland." Mr. Thomson makes no mention of the fact that the engine which went first over the ground, weighed but 5 tons 4½ cwt., cost but 300*l.*, and took a load of 5½ tons behind it, while the "Sutherland," with its india-rubber tyres, weighed 10 tons 8¾ cwt., cost 750*l.*, and failed to take a load of 5 tons. Neither does he remember to record that, with the exception of the final failure, the chief delays with the "Sutherland" took place at points of the course where no slipping or digging had occurred with the spudded engine, while, finally, he in no way alludes to the important fact that, after the road had been cut up by the "Sutherland," and after the thunderstorm, on the effect of which he places so much stress, the whole course was run by Mr. Burrell's ordinary rigid-wheeled engine, and subsequently by Messrs. Aveling and Porter's 10-horse engine, the former drawing a load of 7 tons, and the latter one of 9 tons. We should have thought that in a paper intended for discussion by a body like the British Association, it would have been only just to have stated these facts, even at the risk of placing the performance of the road steamer in a less favourable light. In place of doing this, however, Mr. Thomson attempts to decry the test "as a purely artificial one," and asserts that "no farmer would ever dream of sending an engine upon his land in that state for any practical work." Curiously enough, however, he states, only a few lines lower down, that "in a neighbouring county, *on land in precisely the same condition*, and during heavy rain, another road steamer, with tyres 18 in. broad, in the presence of a large company, was ploughing by direct traction 5½ acres in 5½ hours." We leave Mr. Thomson to reconcile these two statements.

Mr. Thomson, moreover, attempts to account for the failure of the "Sutherland" by stating that it "lacked the distinctive qualification of Mr. Thomson's farm steamers, its tyres being only 12 in. broad instead of 18 in. Moreover, the engines which Mr. Thomson mounts on these tyres weigh about 7 tons, while the "Sutherland's" weight was 10 tons 4 cwt." Now, the fact is that the tyres of the "Sutherland" were 15 in. not 12 in. wide; but we suppose that Mr. Thomson desires it to be inferred that they should have had a width exceeding that of the tyres of the 7 ton engines in the same proportion as the weight of the "Sutherland" exceeded 7 tons. This would have given for the "Sutherland" tyres about 27 in. wide, and no doubt the use of such wide tyres would have much improved the performance on soft ground; but Mr. Thomson neglects to point out that the use of such tyres (supposing the same thickness to have been maintained) would have increased the cost of the engine by over 200*l.*, a matter of considerable importance to a farmer, while we are unaware of any trials at Barnhurst or elsewhere, the results of which prove that on soft ground the supporting power of the india-rubber tyres is superior to that which can be obtained by the employment of rigid tyres of sufficient width. We may remark, by the way, that it is somewhat curious that "a neighbouring county" should have been chosen in preference to the Royal Agricultural Society's trial grounds for displaying the ploughing capabilities of the Thomson steamer. It is, to say the least of it, singular that an engine which is stated by its admirers to possess such wonderful powers of ploughing by direct traction should so carefully avoid a public competition where so much honour was to be gained, and where, from the judges being men thoroughly qualified for their work, the results obtained and recorded have a real practical value.

Returning to Mr. Thomson's paper, we next find him referring to the run of the competing engines between Wolverhampton and Stafford, the results of which he dismisses in the words: "The distance was 16 miles, and the road steamer 'Sutherland' beat all the other engines by 45 minutes." This is not quite correct, and it is certainly far from being the whole truth. The fact is that the "Sutherland" beat the fastest rigid-wheeled engine by 40 minutes net running time, but it is also a fact that this latter engine beat the second road steamer by 55 minutes, and of this fact Mr. Thomson makes no mention. Neither does he apparently think it worth while to record that, whereas the "Sutherland" burnt 3.75 lb. and the second road steamer 5 lb. of coal per mile per ton of load hauled, the fastest and second fastest traction engines with rigid wheels burnt but 2.73 lb. and 2.5 lb., respectively; while, further, in speaking of the speeds, he makes no allowance for the fact that whereas the fastest traction engine drew a load equal to 1.72 times its own weight, the "Sutherland" took a load of 1.03 times its weight only, a somewhat important difference.

We now come to Mr. Thomson's account of what he terms the fourth trial, namely, that in which the "Sutherland," and Messrs. Aveling and Porter's 10-horse engine were tested on the high road near Tettenhall. Mr. Thomson's account of these experiments is as follows: "The 8-horse power road steamer 'Sutherland' took 36 tons over this course in 10 minutes with perfect ease. The 10 horse power rigid-wheeled traction engine took 38 tons over the same course in 50 minutes with considerable slipping and difficulty, *showing that the road steamer would do as much work in 2 hours as the rigid-wheeled engine would do in* 10 *hours.*" We have ourselves italicised the latter part of this quotation, as we consider it to be one of the most remarkable deductions ever introduced into a paper submitted to a scientific body. The real facts of the case were, that both the engines referred to, took up the same train, weighing 26 tons 4 cwt., the gross weights, including the engines, being, in the two cases, 36 tons 14 cwt. and 37 tons 3 cwt. 3 qrs. respectively. As we explained in our account of this trial (*vide* pages 21 and 22 of the present volume), the load was undoubtedly too great to be taken up with ease by the rigid-wheeled engine, fitted as it was with a class of wheel not adapted for giving the best results on a hard macadamised road, and hence there was, as stated by Mr. Thomson, an amount of slipping which caused great delay. But to argue that, because under these particular circumstances Messrs. Aveling and Porter's engine was five times as long ascending the hill as the Thomson steamer, the latter was therefore capable of doing as much work in two hours as the former in ten, is simply thoroughly absurd. A very slight reduction of the load would have enabled the rigid-wheeled engine to have made the

trip in the same time as the "Sutherland," while it is more than probable that had the former engine been fitted with rigid wheels with wrought-iron cross bars such as are used on a number of Messrs. Aveling's engines, the trip would have been made without difficulty, even with the same load as the "Sutherland." The comparatively small adhesion obtained on such a road by smooth cast-iron wheels was well illustrated by the subsequent trials of the "Sutherland" with wheels of that class to which Mr. Thomson refers.

In concluding our remarks on Mr. Thomson's version of the results of the Wolverhampton trials we may again disclaim any antagonism to elastic tyres *per se*. We most willingly admit that on certain surfaces, such, for instance, as that of a hard and dry macadamised road, the india-rubber gives materially increased adhesion; but in by far the majority of cases in which traction engines are employed we consider this extra adhesion far too dearly bought by the employment of such an expensive—and to a certain extent treacherous—material. The experiments at Barnhurst clearly showed that for farm purposes the india-rubber tyres possessed no advantages over rigid wheels. As for employing the Thomson steamer for the purpose of ploughing by direct traction, we regard it simply as a mode of doing with difficulty what can be done with ease in other ways. No doubt there are circumstances under which the Thomson engine can traverse the land and haul a plough behind it, but under similar circumstances there are plenty of other far less expensive engines which could do the same, while the Barnhurst trials proved that ordinary ploughing engines could get into place and do their work under circumstances which rendered the road steamer entirely helpless.

As for the questions and answers relating to one of his road steamers in use by the War Office, given by Mr. Thomson in his paper, they possess, as they stand, no practical value whatever, as they afford no definite information as to the kind of work on which the engine has been employed; and the same remark will also apply to much that has been said and written concerning the advantages of engines with india-rubber tyres.

INDIAN RAILWAYS.

THE blue book on Indian railways, containing the report for 1870-71, is now before us. From it the following facts are learned relative to the progress of construction made with those lines during the past year. At the commencement of the year 1870, a length of 4283 miles of railway was open, and during the year 557 miles were added. Since the commencement of this year a further extent of 211 miles has been finished; so that, at the present time, the total length of railway open in India is 5051 miles, of which 710 are constructed with a double line of rails. Altogether 7482 miles of railway have been sanctioned, so that there now remain, of these, 2431 miles to be completed, of which 1305 miles will be of the newly adopted narrow gauge of 3 ft. 3⅜ in., and the remainder of the standard Indian gauge of 5 ft. 6 in. All the lines already constructed are of the standard broad gauge, with the exception of a short branch of 27½ miles in length, extending from the East India Railway at Nulhattee to Moorshedabad, which is of a 4 ft. gauge. Of course, long before the lines already sanctioned have been completed, it may be expected that a considerable addition will have been made to the sanctioned lines, since several projects for State Railways have been prepared, or are being prepared, for final approval; and if the contemplated addition to these lines be really intended to be vigorously carried out, we may look for a considerable addition to them in next year's report.

The most important section that was completed during the year was that from Sohagpore to Jubbulpore on the Great Indian Peninsula line, by means of which railway communication between Bombay and Calcutta was established. The opening took place early in March, 1870. Next in importance to this event in the railway annals of the year was the completion of the whole length of railway between Calcutta and Lahore, by the opening of the last remaining section on the Delhi and Punjab line. Since the end of the year, the lines from Bombay in a south-easterly direction, and from Madras in a north-westerly direction, have met at Raichore, the point of junction fixed upon, and a train service has been established between those two presidencies. Thus may the system of trunk lines for India, originally laid down by Lord Dalhousie, be regarded as completed. The three presidency towns are united, and the North-west Frontier has been brought into railway communication with the southern portion of the Peninsula Commencing at Negapatam, the most southern terminus of the present Madras system, and proceeding by Bombay, Jubbulpore, Allahabad, and Lahore, to Mooltan, on the Indus, a continuous length of about 2800 miles of railway has been formed. The extension line of the Eastern Bengal Railway, which terminates at Goalundo, at the confluence of the Ganges and Brahmapootra rivers, was opened by the Viceroy on the last day of the year. It will form a valuable addition to the original line, as much of the up-country traffic which formerly went on these rivers will now flow to the railway. Since the end of last year the chord line of the East Indian Railway has also been opened for traffic. A saving of 65 miles in the journeys from Calcutta to the north-west and to Bombay is effected by this route, and great facilities are given for making the coal of the districts through which the line passes available for this and other railways in Upper India.

So much for the guaranteed railways. We must now notice what progress has been made with the State Railways, some of which will be constructed on the new narrow gauge, whilst others, mostly short branches from existing lines, will be, or have been, constructed on the old broad standard gauge. As might have been anticipated, all things considered, much progress has not at present been made with these lines. A small branch from the Great Indian Peninsula Railway to the cotton mart of Oomrawuttee, 7½ miles in length, has been opened, making the second line of this description which has been constructed by Government in the central provinces; but the line from Lahore towards Peshawur has not been advanced beyond laying it out as far as Jhelum, a distance of 102 miles. Delay in proceeding with the works in this undertaking has been occasioned by the proposal to alter the designs, which had been prepared for the standard gauge, to adapt them to the narrow gauge. It is estimated that 200,000*l.* will be expended on this line during the present year. The total cost of the whole, which is 270 miles in length, will be about 3,000,000*l.* The Indus Valley Railway is also to be constructed on the narrow gauge. Its northern portion has been laid out, and is about to be commenced; it starts from a point six miles west of Mooltan, on the Punjab Railway, and runs through Shoojabad and Bharoulpore to Sukkur. The lower division extends from that place to Kotree, and is beset with difficulties arising from inundations. A committee is investigating the route on either side of the river, and will report which they consider to be the more favourable for the construction of a railway. With regard to the projected railways in Rajpootana, lines have been surveyed from Agra to Ajmere, *viâ* Jeypoor and Sambhur, 236 miles, and from Delhi *viâ* Rewaree and Tellour, 125 miles, to join the above, with a branch of eight miles to the salt works. Operations have commenced on the line between Delhi and Rewaree, which will involve an outlay of 50,000*l.* during the present year. The line to Ajmere will probably be taken ultimately on to Indore, from which place to Khundwa, on the Great Indian Peninsula Railway, a line 84 miles in length has been laid out. The line from Carwar to Hoobliee, south of Bombay, is still under consideration. The difficulties of this scheme, and the expensive nature of the works over the ghauts, made it necessary to survey the ground afresh, and more favourable gradients and easier works than were originally contemplated, have now been found practicable. The railway from Goolburga, on the Great Indian Peninsula, to Hyderabad, which is to be constructed with funds provided by the Nizam, has been laid out and commenced. It will be about 116 miles in length, and will go by Secunderabad and Trimulgherry, and, at the particular desire of the Nizam, it will be constructed on the broad gauge.

As being intimately connected with railways at Calcutta, it is stated that the crossing of the Hooghly at Calcutta by a floating bridge has been determined on. It is estimated to cost 180,000*l.*, and has been placed in the hands of its projector, Mr. Leslie, late chief engineer of the Eastern Bengal Railway, who is preparing the materials for its construction in this country.

The actual expenditure upon guaranteed railways had amounted, on the 1st of April last, to about 88,064,000*l.* Of this 5,500,000*l.* was expended during the past year, and about 614,000*l.* represents the capital of the Calcutta and South-Eastern Railway Company now in the possession of Government. The total amount of capital which, it is estimated, will be required for the lines which have been sanctioned, including those open and those incomplete, is estimated at about 100,000,000*l.*, of which 91,102,810*l.* has been raised and paid into the Government treasury. The present financial year begins with a balance of about 3,652,995*l.* in favour of the companies towards the expenditure of the current year, which has been estimated at 4,600,000*l.*, of which 1,985,000*l.* will be in England. During the past year 465 vessels have been employed in conveying to India 263,449 tons of stores and goods for the Indian railways, of a total value of 1,681,512*l.* The total value of goods sent out since the commencement of operations has been 28,173,128*l.* The following statements show the amount of capital expended by the companies named to the 31st of March, 1871, the cost per mile, and the manner in which the expenditure was distributed:

Railway Company.	Length opened 31st March, 1871.	Cost to 31st March, 1871.	Cost per mile.
	Miles.	£	£
East Indian	1503	30,401,276	20,227
Great Indian Peninsula	1272	22,417,464	17,623
Madras	832	9,748,135	11,716
Bombay, Baroda, and Central India	312	7,436,700	23,833*
Sind, Punjab, and Delhi ...	675	10,106,700	14,972
Great Southern of India ...	168	1,454,666	8,658
Eastern Bengal ...	159	2,860,667	17,928

* This represents an expenditure on a cerfain portion of line not yet open.

Railway Company.	Works and bridges.	Permanent way and stations.	Freight and insurance.	Rolling stock and engines.	Establishments.	Miscellaneous, electric telegraph, stores, &c.
	£	£	£	£	£	£
East Indian	9,530,000	7,115,000	2,975,000	3,450,000	3,700,000	3,685,000
Great Indian Peninsula	9,077,553	7,051,054	1,661,231	2,727,866	1,551,965	202,301
Madras	3,008,635	3,608,920	...	1,048,084	806,232	407,931
Bombay, Baroda, and Central India...	3,081,211	1,824,368	...	1,079,037	717,144	735,810
Sind, Punjab, and Delhi*	1,966,837	3,395,957	759,368	1,218,447	1,028,250	1,193,979
Great Southern of India		1,607,555		133,835	175,285	72,567
Eastern Bengal...		2,020,578		202,785	805,052	193,118
Oude and Rohilkund	285,360	760,380	...	117,380	211,180	105,210
Carnatic...	6,100	31,599	...	12,063	11,264	12,279

* Indus steam flotilla—steamers and barges 378,301*l.*, warehouses and workshops 45,504*l.*—not included in the above statement.

The revenue derived from the railways during the year ending 31st December, 1870, amounted to 2,846,600*l.*, being about 340,000*l.* in excess of the previous year. The gross receipts, in 1870, were 6,213,865*l.*, compared with 5,709,382*l.* in 1869, and the expenses 3,367,261*l.* and 3,303,171*l.* respectively. The amount paid by the Government for guaranteed interest during the corresponding period was in excess of the net receipts by 1,366,000*l.*, entailing to that extent a charge on the revenues of the country. Of this, however, a sum of 500,000*l.* may be taken as having been paid upon capital not

yet representing open or productive lines. The gross receipts from passenger traffic, in 1870, were 1,924,378*l.*, being 187,210*l.* in excess of 1869, when they were 1,737,168*l.* Those from goods traffic were 4,149,978*l.* in 1870, and 3,808,767*l.* in 1869. Miscellaneous receipts were 139,509*l.* and 163,447*l.* respectively. The general results with regard to passenger traffic show that the passenger tickets numbered 18,224,859, of which 135,829 were first class; 603,486 second; 584,980 intermediate; 14,181,221 third; and 2,719,343 fourth, or coolie. Thus the third and fourth composed 92.72 per cent.; the second and intermediate, 6.52 per cent.; and the first only .76 per cent. of the whole. Each first-class passenger paid 14s., and travelled 112 miles, at 1½d. per mile; each second-class passenger paid 4s. 1¾d., and travelled 48 miles, at 1.02d. per mile; each third-class passenger paid 1s. 8½d., and travelled 58 miles, at .35d. per mile; each fourth-class passenger paid 1s., and travelled 40 miles, at .30d. per mile. Taking the passenger trains alone (exclusive of mixed and special), the average distance run by each train was 104 miles. The merchandise carried amounted to 2,633,687 tons, exclusive of coal, coke, and minerals, of which there were 801,582 tons. According to the returns furnished from India by the several companies, the average distance run by each train, with goods, would be 144, and with minerals, 51 miles. The average amount paid for each ton of merchandise would be 1*l.* 5s., and of minerals, 6s. 7d. Thus the average amount paid for each ton of merchandise per mile would be 2.08d., and for each ton of minerals, 1.5d.

The train mileage receipts of the various lines vary from 3.80s. on the Calcutta and South-Eastern; to 10.55s. on the Bombay, Baroda, and Central India, the East Indian and the Great Indian Peninsula being at about the average, between 8s. and 9s. The train mileage expenses also vary, and bear a different proportion to the receipts in almost every case. While those of the Bombay, Baroda, and Central India, and the Sind, Punjab, and Delhi are at 6.39s. and 6.27s., those of the East Indian, the Madras, and the Great Southern of India are at 3.62s., 3.47s., and 3.55s. respectively. Thus the net mileage receipts of the East Indian main line are brought to 4.82s., the Great Indian Peninsula to 8.30s., the Madras to 2.88s., the Bombay, Baroda, and Central India to 3.96s., the Eastern Bengal to 4.20s., and the Sind, Punjab, and Delhi to 1.54s. A comparison of the departmental charges on the different lines may help to indicate where there is room for improvement. The Bengal lines at present have an advantage over those on the west coast and in Madras in respect of the supply of coal for fuel, but there appears to be no sufficient reason why the locomotive departments of the Great Indian Peninsula and Bombay, Baroda, and Central India Railways should be at 22.33d. and 23.05d. per train mile respectively, while those of the Madras and Great Southern of India are 15.45d. and 15.57d. The traffic charges likewise in some cases present a contrast which seems to call for explanation. On the Sind, Punjab, and Delhi Railway the traffic expenses per mile reach 16.03d.; on the Oude and Rohilkund, 15.62d.; and on the Eastern Bengal, 15.37d.; while on the East Indian they are 8.64d.; on the Madras, 6.93d.; and on the Great Southern of India, 6.35d. The fuel question is always an important one in connexion with the working expenses of Indian railways, and it is satisfactory to find that native coal will soon be more extensively used. The coal from the Nerbudda fields is at length likely to be available for the railways in Central India. A tramway from the pits to the Great Indian Peninsula Railway is now being laid down, and the railway company has engaged to take a certain quantity monthly at a fixed price. Sanguine hopes are also entertained with respect to the Chanda coalfields, specimens from which have been favourably reported on after experiments with them. The mines are situated to the south of the Nagpore branch of the Great Indian Peninsula Railway, and a line is being laid down by the Government with the main object of obtaining a good supply of fuel from this source. With these aids a considerable reduction should take place in the working expenses of the locomotive department of the Great Indian Peninsula line, and more favourable results produced by the traffic. A regular system has been organised in the Madras Presidency for obtaining an adequate supply of wood fuel for railway purposes. It has been estimated that nearly 100 square miles will be required to meet the demand; and already measures have been taken by the forest department for demarcating 26 miles in the districts of Cuddapah, North Arcot, Salem, and Coimbatore to be used for the cultivation of trees suitable for the working of the railways, and similar measures have also been adopted in the Punjab and Sind.

To return to the projected State lines. No accurate estimates have yet been made of their cost, but the following figures will give an approximate idea of the money required for those which have been decided upon:

	Length. miles.	Estimated cost.
Punjab Northern, from Lahore to Peshawur	270	£3,000,000
Indus valley, from Mooltan to Kotree	500	5,000,000
Rajpootana { from Agra to Ajmere ...	236	2,500,000
Rajpootana { from Delhi to the above branch to Salt Works...	125 / 8	2,500,000
Indore to Khundwa on the Great Indian Peninsula Railway ...	84	800,000
Wurda, on the Great Indian Peninsula Railway to coalfields at Warora	45	300,000
Carwar to Hoobles	60	700,000
	1328	£12,300,000

During the year 1870-71 a sum of about 280,000*l.* has been expended by the Government on surveys, plans, and certain materials connected with the foregoing projects; and the short line of 7½ miles, connecting Oomrawuttee with the Great Indian Peninsula Railway, has been constructed for 30,000*l.* In the year 1871-72 it is calculated that about 1,500,000*l.* will be required by the Government, but no actual estimates or accounts have yet been received from the Government of India. In addition to the above-mentioned lines, one from Goolburga on the Great Indian Peninsula Railway to Hyderabad, 116 miles in length, has been undertaken by the Nizam, who will expend on it this year a sum of about 250,000*l.*

THE STOWMARKET EXPLOSION.

THE most lamentable explosion at Stowmarket, on Friday last, which, without warning, caused so wholesale a devastation in life and property, has done something more than kill and destroy. It has apparently upset a theory, and scattered to the winds all the comfortable conclusions as to the safety of gun-cotton, its use and manufacture, which prolonged investigation and experiment appeared to warrant. At least this is the conclusion to which we are for the present led, and which we must maintain, unless the approaching inquiry shall throw any new light upon the subject. Until that inquiry has been concluded, suggestions as to cause are necessarily idle, mere guesswork, based on conjecture. Unfortunately, it is certain that unless some clear cause can be found for the disaster, all confidence in the safety of gun-cotton will be destroyed, the progress and introduction of explosives will be checked, and utter doubt will be thrown upon the investigations which able chemists have conducted. For our own part, we have little doubt that no mysterious or occult agency had to do with the accident, but that it arose from perfectly clear and well defined causes, that do not stultify the experience of past years gained in the manufacture of gun-cotton. We fear, however, those able to throw light on the matter have fallen victims, and that satisfactory results are scarcely to be hoped for from the investigation.

The works of the gun-cotton manufacturing company, in which Messrs. Prentice are the principal partners, are situated on a stretch of meadows about three-quarters of a mile from the town of Stowmarket in a north-easterly direction. On their western side runs the high road to Ipswich and a small navigable canal called the Gipping, the eastern side being bounded by the Great Eastern Railway. A small island has been formed on the works by cutting a loop line, and so diverting the course of the Gipping, and on this strip of land were the mixing or dipping, and the drying sheds, in which the cotton is passed through the chemical solutions and dried. At the south-eastern end of the grounds stood three magazines about 12 ft. long, 10 ft. deep, and 8 ft. high. The sides were constructed of wood lined with canvas and paper on the interior, and the roofs were lightly covered in with slate. The magazines were built on wooden piles, and were placed 14 ft. from each other, and between them were 9 in. brick walls rising higher than their roofs. They had neither windows nor skylights, the only openings being the single door in each. They were used to store the finished gun-cotton until sent away from the works. At the time of the explosion each magazine contained about 5 tons of the material, part of an order which was being executed for the English Government. At the north-eastern end of the works, and about 900 ft. from the three magazines, is a building similar in character to them, and which is used as a store for rifle cartridges. About 130 hands, men, women and children, are employed on the establishment, and they had just resumed work after the dinner hour on Friday last, when a fearful explosion occurred on the site of the three magazines to which we have alluded. To those on the works who are able to give any account of the occurrence, there appeared to be but one explosion, whilst in the town of Stowmarket three distinct explosions were heard to follow each other in very rapid succession. The workpeople rushed from the tottering sheds around, only to be killed or injured by the falling débris.

It so happened that none of the Messrs. Prentice were on the works at the time of the explosion, Mr. Eustace Prentice, the managing director, being on the Continent, and Mr. Manning Prentice was absent from ill-health. Soon after the explosion, however, Mr. E. H. Prentice, one of the directors, and who is the manager of some neighbouring chemical works, and Mr. W. R. Prentice, second son of Mr. Manning Prentice, were on the spot. They proceeded to collect the workmen, and with them set to work to save such of the buildings as still remained, but which had taken fire. Relying on the results of some experiments which had been carried out, and which proved the gun-cotton, as now manufactured, to be non-explosive except by percussive fire, Mr. E. Prentice was engaged in removing boxes of cartridges from the flames, being assisted by his nephew. Although warned of danger, he still continued his fatal work, when one of the boxes exploded. This explosion completed the fearful work of destruction, and the remainder of the works was rendered an easy prey to the flames. The latest accounts place the number of persons killed by this disaster at 24, the number of wounded being 72, and it is possible that some names in the latter may yet go to swell the former list. Subscriptions are being raised, and a committee has been formed, to apply the money collected to the succour of the wounded, and to the aid of the widows and children of the dead.

"SECTION G."

THE Mechanical Science Section of the British Association, well-known as "Section G," has, during the past few years, been gradually earning for itself an unenviable reputation. The most casual examination of the papers laid before it in recent and former years will show that, not only have its meetings lost their prestige, and almost ceased to be the chosen occasions for laying before the profession accounts of important discoveries and inventions, but that they have become strongly marked by a debasement to the purposes of trade. We are perfectly aware that trade interests enter largely into the production of papers for several of our scientific societies; but, within certain limits, we believe that there can be no reasonable objection to this. The fact that the commercial value of an invention or discovery may be increased by the fact of its being described before a scientific body, is certainly no valid reason for such a description being withheld, so long as the invention or discovery itself possesses sufficient real novelty and scientific interest to render it worthy of discussion by the body before whom it is brought. But, even in such a case, it is essential that the paper should enter thoroughly into the subject with which it deals, and should explain the fundamental principles of the invention or discovery of which it treats in such a way that the matter may be completely and effectively discussed. To such papers, even if written specially in trade interests, we have no objection, as they enable doubtful points of theory or practice to be thoroughly ventilated and discussed, and in this way do much good. But there is another class of papers to which we *do* object, and that most emphatically. The papers to which we refer are those written for trade purposes, and, apparently, for these purposes only. Some of these papers are, in fact, mere "puffs," rehearsing the good qualities, real or asserted, of the invention to which they relate, and suppressing, as far as possible, all qualifications of an opposite kind. Such papers,

devoid as they are of all scientific information, and some of them not containing a single fact calculated to promote real progress, simply debase the society which accepts them, and it is with sincere regret that we find a body like the British Association, which has earned for itself a name in the world, throwing itself open to such debasement.

We had occasion last year to direct attention to the state of affairs of which we have just spoken, and knowing as we did that our opinion on the subject was shared by all who had the interests of the British Association sincerely at heart, we hoped to have found that this year the papers submitted to "Section G" would have taken a wider range, and have dealt with those broad fields of physical inquiry of which so many are now open for investigation. Such has not been the case, however, and we regret to find that in the majority of instances individual interests have received more attention than the general advancement of mechanical science. Cannot the committee of the section by more vigorous action—amongst other things by themselves contributing some really valuable papers, and by unhesitatingly refusing those of an objectionable character—secure a better result in future?

THE "WATERSTAAT" OF HOLLAND.

No. III.

(*Continued from page* 80.)

THE incorporation of Holland with the French Empire in 1810, was the occasion of the sixth organisation of the Waterstaat, the object of the Emperor being to assimilate it to the Corps des Ponts et Chaussées of that Empire. That this period was important, appears from the decrees issued, some of which are still in force. They aimed at a general ordering and organisation of the Waterstaat, and thus, of the Polder boards, they show a just conception of what the state of the country required, and an unmistakable genius of organisation. After the end of the French rule in Holland (1815), the existing administration of the Waterstaat was maintained, but with such modification that its connexion with the Home Office was merely nominal, it became virtually a separate department. By a royal decree (16th of September, 1815), a separate department of the Waterstaat was set up with the Duke van Ursel at its head. On the 25th July, 1816, the seventh organisation of the Waterstaat was completed. By it, the kingdom of Belgium, which formed part of the monarchy, was distributed into four departments and sixteen districts, and it was further ordered that the control of the Waterstaat should be carried on under the Secretary of State, by (*a*) the corps of engineers of the Waterstaat and Public Works, composed of one inspector-general, 20 engineers-in-chief, first class, 20 engineers-in-chief, second class, 25 engineers, first class, 25 engineers, second class; (*b*) by those employed in regular or temporary service attached to the corps but not members of it, such as Aspiranten, intended to enter it, Conducteurs who could enter it only in particular cases, as when they were distinguished by extraordinary attainments or experience and regular and temporary Pikeurs. The Inspectors-General were J. Blanken and A. F. Goudriaan. This brings us to the close of the first period of the history of the Waterstaat and of the corps of engineers.

The commencement of the second period, from 1817 till 1830, is marked by a departure from the principle upon which only one inspector-general was to be appointed. However expedient it may have seemed by that means to secure the services of two very clever and experienced hydraulic engineers, nevertheless the measure was injurious to the interests of the Waterstaat, and of the corps of engineers. During the early part of his reign, the impulse was given to most of the great works of the time, by King William I. himself. The works at the Niemwediep were resumed, the dyking of the Koegras was undertaken, and the Grand Canal of North Holland dug. The Federik Canal, the canal through Voorne, the discharge at Steenenhoek, the Fuid Willems Canal from Bois-le-Duc to Maastircht, the Willems Canal from Zwalle to the Yssel, the Ternengen Canal, the canal from Hattem to Apeldoorn, and the draining of the Fuid-plas, besides the improvement of communication by the commencement of new roads, and the completion of the highways of the kingdom, need only be mentioned. The draining of the Lake of Haarlem, the Rhine Railway in Holland afterwards, and the establishment at Seraing in Belgium afford more or less evidence of his enterprising spirit. Notwithstanding this great variety of subjects engaging his attention, and his desire to advance the general prosperity of the country, the control of the Waterstaat never ceased to be his constant care, and the decrees issued by him, though opinions may since have been somewhat modified, must be considered as belonging to the most important royal decrees of those times, viz., that by which the patriarchal institutions of Polder-motes, Dyke-motes, &c., was regulated, that defining the control and supervision of sea and river watercourse works, maintained by boards, communes, or private persons, and that prescribing the conditions upon which peat digging, and the clearing of land shall be undertaken. The old quarrel about a general and a departmental government arising again, soon terminated the organisation of 1816. The assertion was made that the department of the Waterstaat had led to too great centralisation, and that by an abuse of the Constitution, the National Government had been loaded with business, which could be done at less cost by the Provincial Governments. Thus on the 27th June, 1819, it was resolved that as soon as certain works, under the control and supervision of the Provincial Governments shall be finished, and in every case not longer than the 1st January, 1820, the general administration of the Waterstaat and public works shall cease to be a separate department, and be transferred to the Home Office. We now come to the eighth organisation of the Waterstaat, fixed by decree of the 17th December, 1819.

By this decree the control of some works was transferred to the Provincial Governments, and another organisation of the corps of engineers appointed, which was to be composed of 1 inspector-general, 4 inspectors, 18 engineers-in-chief, 1 engineer-in-chief for draining operations, 1 engineer-in-chief for mines and quarries, 50 engineers, 12 aspiranten, and 12 conducteurs in regular service; of these functionaries those particularly attached to the department and at the disposal of the minister were: the inspector-general, 4 engineers-in-chief, including those for draining operations and mines, 8 engineers, the 12 aspiranten, and 5 conducteurs in regular service, partly to satisfy a provision which required the holding of an annual meeting under the presidency of the minister to inquire into, and advise upon, the plans of the general and departmental Waterstaat. The office of Inspector-General was still held jointly by J. Blanken and A. F. Goudriaan.

In each province an engineer-in-chief, or in his stead an engineer, was appointed by, and in the pay of, the National Government, but he was to receive his orders from the governor and states of the province. He was to be assisted by as many engineers as, on the recommendation of the states, it might be deemed expedient to appoint; for whose payment the states of the province were to provide. This organisation had a serious and injurious effect on the corps of engineers of the Waterstaat on account of the anomaly it contained, namely, that the engineers-in-chief were under the orders of the provincial states and, in respect of provincial works, did not receive any orders from the minister. On the other hand they were required to take care that neither by the provincial states, nor by the dyke-motes, &c., anything concerning the Waterstaat or public works should be done opposed to the general interests. The engineers were thus placed in a false position, by which they were neither national nor provincial officers; and had to supervise the actions of those whose orders they were to obey. Since 1785 nothing had occurred even in the administration of the Waterstaat that occasioned more difficulty than the decree of 1819. The decree of 1820, by which the control of the Waterstaat was transferred to the home officers, was so modified by another decree (September 17, 1823), that the whole control, instead of being spread over several departments, became one administration again, under a board appointed by the minister, at the head of which the Inspector F. A. Goudriaan was placed. Meanwhile the great works in progress were continued. In 1824 large sums, and in 1825, 8,000,000 florins were voted for the draining of the Fuid-plas, for the Federik canal, for repairing the works damaged by the storms and high floods of February in that year. At this time the committee intrusted with the inquiry as to the best means of directing the courses of the rivers, published its famous and interesting report, which gave rise to the execution of more or less important works on the Yssel in Guelderland, the commencement of the Lymers overlet, the limitation of the old mouth of the Rhine, the enlargement of the Baardwyk overlet, &c., to several regulations of an administrative character, and to the appointment of a second river committee in 1828. Although their advice has never been strictly followed, great praise is due to a committee, which at that time, with regard to the corps of engineers, boldly showed the necessity of withdrawing entirely from provincial influence all those who were intrusted with works of public interest or with the management of the rivers; an influence which, as the committee declared, the history of the Waterstaat teaches has been but too often quite antagonistic, nay, even fatal to the dearest interests of the country.

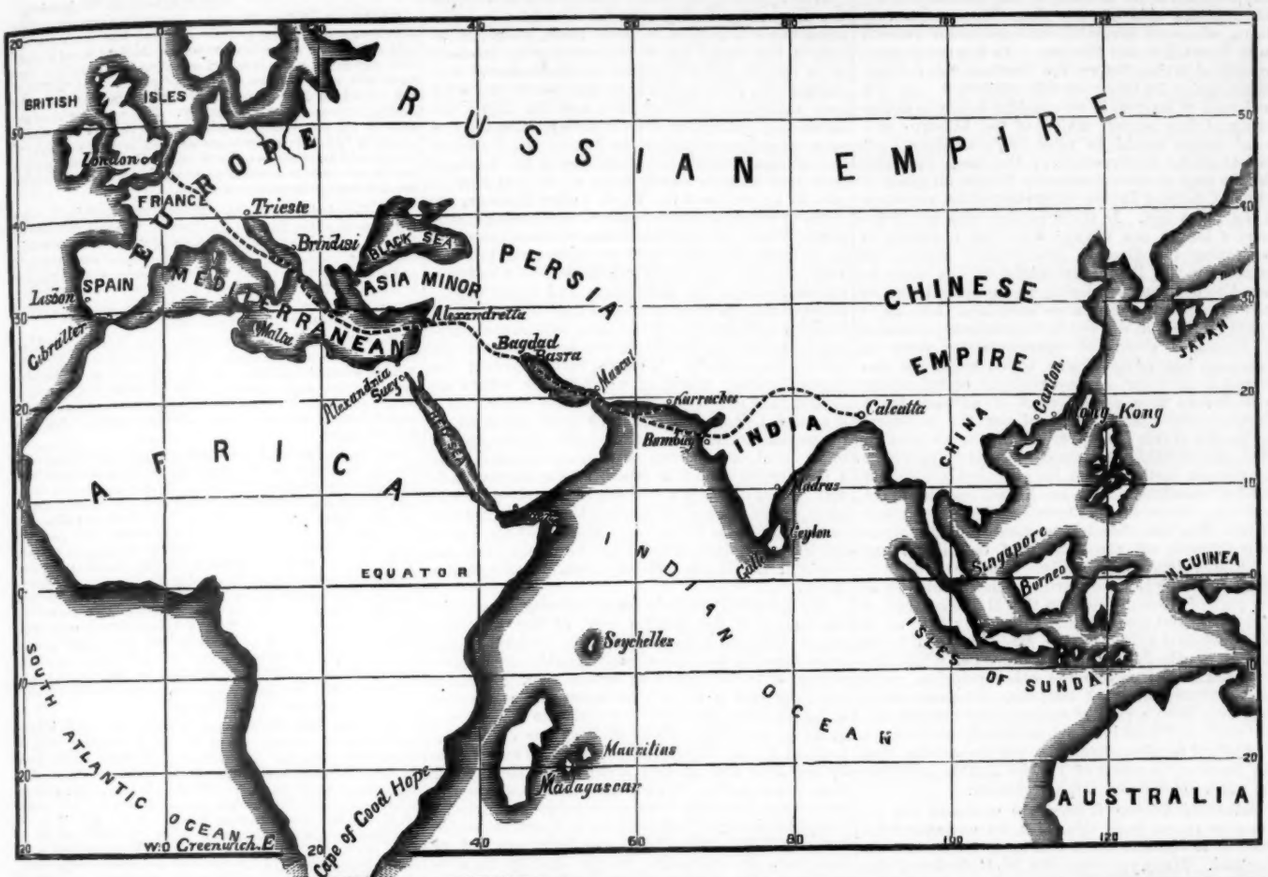
In 1826, on the retirement of J. Blanken, A. F. Goudriaan became inspector-general and Ew k administrator of the Waterstaat. In 1828, Goudriaan died, his office remained unfilled till 1829, but to carry on the existing administration, four inspectors were appointed. On the 12th of August, 1822, a Royal decree was issued, far more prejudicial to the interests of the Waterstaat and to those of the corps of engineers than that of 1819; by it, all roads, canals, ferries, draining operations, with their appurtenances, steam engines, sluices, bridges, vessels, pontoons, and the like, were placed under the immediate control and maintenance of the "Amortisation Syndicate" and works so important as highways of the first and second class, and those which were maintained by the country, the great works mentioned above, with the ferry between Willemsdorf and the Moerdyk were placed under the control of a permanent committee composed of men totally unacquainted with matters concerning the Waterstaat. There was, it is true, a provision by which, when, for the control, renewing, reparation, or maintenance of certain works, more technical knowledge was required than might be expected from the members of the "Amortisation Syndicate," they might call in the assistance of the administration of the Waterstaat. This provoked some humorous verses from the pen of F. W. Conrad who was as little pleased with the arrangement, as were his fellow-engineers. In 1829, the administration of the Waterstaat and public works was removed from the Home Office, and associated with the department for the colonies, P. L. J. S. Gobbeschroy being the minister. The two departments requiring talents so divergent, were carried on with perfect mutual forbearance until the year 1830, so memorable for the country, and which we take as closing the second period of the history of the Waterstaat.

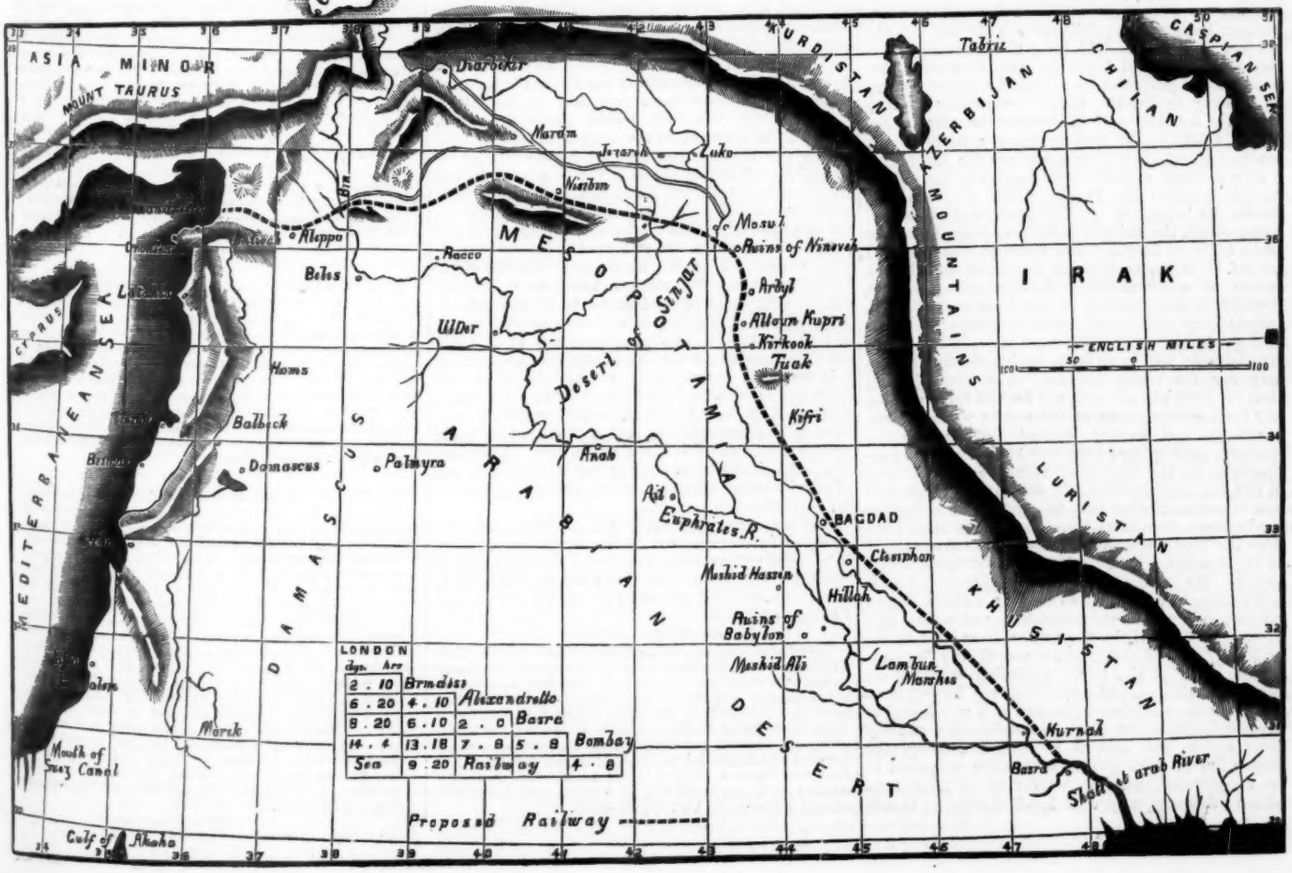
(*To be continued.*)

NEW OVERLAND ROUTE TO INDIA.

THE question as to the most expeditious line of communication between England and India is one which may at some future time resolve itself into the question of our being able to retain possession of our Eastern dominions. That route which at the same time runs in the most direct line, and has the least amount of sea to be traversed, must, in the absence of political considerations, be the most desirable, as it would be also the quickest in point of actual distance to be traversed. A purely maritime route would undoubtedly be the safest from probability of interference in the event of any misunderstanding with such a power as Russia, whose traditional aspirations have always been directed towards the East Indies, and those who watch the progress of events in Central Asia cannot fail to have observed how slowly, but surely, that power is closing in towards our North-western Frontier in India, from which direction every great invasion of that country, with the exception of our own (which can perhaps hardly be looked upon in such a light), has taken place. Although we do not fear any actual invasion on the part of Russia, yet it must be admitted that from her position on our frontier she might occupy a considerable portion of our army in that direction, in the event of its being considered desirable by her to create a diversion in India, so as to prevent our interference in any European complications in which she might be interested. So far as we at present know, the Committee of the House of Commons on "The Euphrates Valley Route" are likely to have alternative routes submitted to their consideration, one of which would start from Trebizond, or some other port on the Black Sea, and the other, taking its start from the port of Alexandretta on the Mediterranean would pass

THE PROPOSED NEW OVERLAND ROUTE TO INDIA.





through Turkish Arabia, *viâ* the valley of the Tigris, instead of down the Euphrates, joining the line of that proposed route probably at Bagdad, only taking the opposite side of the river Tigris, down to Basra, whence a navigable communication extends on to Kurrachee and Bombay. As it must be some considerable time before the Parliamentary Committee makes its report on this subject, it may not be devoid of interest if we consider briefly in anticipation of that report, which of the hitherto proposed routes would be most likely to adapt itself best to all the requirements of the case. In doing this we may at once summarily dismiss all ideas of a line of railway having its starting point anywhere in the Black Sea. In the first place this would involve a longer sea voyage with the necessity of navigating the Grecian Archipelago, whilst the entrance to the Black Sea might at any time be closed to us, thus rendering the proposed line of railway, not only useless to ourselves, but, as it would be then, at one end in the absolute possession of Russia, a means of communication from an European base of operations, which might be employed in the event of any political complications with Russia as a second road of advance for a Russian army against India. Upon the engineering merits of this line we are unable at present to offer any reliable statement, but the arguments already set forth against its adoption are to our mind so conclusive that no British capital ought under any circumstances to be embarked upon such a line. We have then left to choose from the alternative routes *viâ* the valleys of the Tigris and Euphrates rivers respectively. Whichever line be ultimately adopted the starting point would be at the port of Alexandretta, on the Mediterranean, a port of ancient renown, and sufficiently high up in the north-east corner of the Mediterranean to be free from silt deposits from the Nile, which has rendered almost useless the other principal ports on the eastern shore of that sea. Alexandretta is also, even now, a port of no mean commercial importance, and from it a comparatively easy ascent is obtained to the summit of the mountains that line the western coasts of Turkish Arabia, and form the water-shed of the Euphrates river.

Before considering further the merits of the alternative routes from this point, let us pause for a moment to consider the line of approach hence from England. Many years ago Mr. W. P. Andrew, who has always most consistently advocated the Euphrates Valley line, published a pamphlet on the subject, in which he laid down the entire route between England and India, in connexion with that line. In this pamphlet he proposed to cross Europe by railway to Trieste, thence proceeding by ship down the Adriatic and Mediterranean seas to Seleucia, a port in the Mediterranean a little to the south of Alexandretta, from whence the Euphrates Valley Railway would convey goods and passengers to the head of the Persian Gulf, for transport thence by steamers to Kurrachee and Bombay. Long before the Brindisi route was adopted for the mails between England and India, it was proposed by Mr. G. Latham, C.E, as the most expeditious means of communication in connexion with a Turkish Arabia Railway to the Persian Gulf, thus substituting additional railway distance on the European side, in the place of the sea trip down the Adriatic, and in so far lessening the time necessary for the whole journey. This route having thus far been already adopted for the Indian mails, any further arguments on its merits would be superfluous, and having arrived thus far on the journey, we may now turn our attention more particularly to the two rival routes across Arabia. When the Euphrates route was first proposed, it was in contemplation only to construct a comparatively short line of railway to connect that river with the Mediterranean, and then by improvements in its channel, to render it navigable down to its mouth. By referring to the accompanying map it will clearly be seen that, so long as a short line of railway only was in contemplation, and a long line of navigable river, the Euphrates, from its relative position to the Mediterranean, was clearly the preferable river of the two. Attention was thus directed to this line, and a rough survey having been made of the neighbouring country, it was found to present facilities for the construction of a railway from end to end, and as a natural consequence such a line of railway was soon after proposed to be constructed, without, so far as we have been able to discover, any trial levels being run in any other direction in order to ascertain whether a more favourable line could be discovered, nor do any inquiries appear to have been instituted as to whether the Euphrates Valley afforded the best possible advantages in respect to local trade, which, in so long a line ought not, in the commercial interests of so vast an undertaking, to be overlooked. Unfortunately, for a complete comparison between the two valleys of the Euphrates and the Tigris, the latter does not appear ever to have been so fully or so accurately surveyed as the former, but the whole line of country has been passed over by Mr. Latham, and after such an examination as he was able to give it, he projected the Tigris Valley Railway, the route of which is shown in the accompanying sketch map. From the experience thus obtained there can be no doubt but that, from an engineering point of view, the line is perfectly practicable for a railway, presenting but few difficulties, and those chiefly between the Mediterranean and the Euphrates, and which would therefore be common to both the alternative routes by the Euphrates and by the Tigris valleys respectively. It cannot be denied that the Tigris Railway would of necessity be somewhat longer than one down the Euphrates River, but it is doubtful whether it would be more expensive in proportion to its increased length, whilst, on the other hand, its chances of proving productive of a local traffic are all in favour of the Tigris Railway, which not only would run near to the principal trade routes between Persia and the Mediterranean, but it would also follow the direction of the existing telegraph lines, which have been laid along the banks of the Tigris, and *not* down the Euphrates River.

We purposely refrain from entering upon the question as to the relative cost of the two lines, for on both of them the surveys hitherto taken have been far too incomplete to enable any reliable estimates to be formed in either case. The only estimates ever made for the Euphrates line are also of far too old a date to be anything like trustworthy at the present day; whilst such as have been put forward for the Tigris Railway are also out of date by this time, and at best were never much more than guess-work. Those who desire to inquire more fully into this interesting subject will find a complete history of both projects in ENGINEERING for January 13th, 20th, 27th, and February 3rd of this year. In conclusion, we find that by the construction of a railway across Turkish Arabia, the distance between London and Bombay might be completed in 14 days 4 hours, of which 9 days 20 hours would be occupied by the sea portion and 4 days 8 hours by the railway portion of the journey. These periods refer more especially to the Tigris Valley route, but they would probably apply, within an hour or so, to the Euphrates line as well. Under any circumstances either must of necessity be more expeditious than if the line commenced from some port in the Black Sea, instead of from a Mediterranean port. We have referred above to the disadvantages that might arise from a political point of view, were the proposed railway to terminate, at one end, on the Black Sea. On the other hand, by having its western terminus at Alexandretta, both ends of the line might be maintained, without fear of dispute, in our own hands, under any circumstances, by the maintenance of suitable naval protection at the Mediterranean end, whilst it is always in our power to protect the other end from any naval attack by simply closing the Persian Gulf against hostile fleets, which ought at any time to be practicable by means of the naval force always maintained in the Eastern seas. This last is a point which must not at any time be left out of consideration when the whole question comes on for final decision.

The accompanying maps, without which any discussion of such a question, as the present one, is often to a great extent unintelligible to the majority of readers who have not previously studied the subject, have been specially prepared for us by Mr. George Latham, of Trieste.

TORPEDOES.—Messrs. Spencelayh and Archer, of the Medway Iron Works, Chatham, have just completed the manufacture of 500 of the largest kind of torpedoes, each to contain a charge of 5 cwt. of gun-cotton, the whole of which have been delivered at the Royal Arsenal, Woolwich. A large quantity of torpedoes, each to contain explosive charges of 3 cwt. of gun-cotton, have likewise been manufactured and forwarded to Woolwich; and the same firm have now taken a contract for the manufacture of a large number of a new description of torpedo, each intended to contain a charge of 1 cwt. of gun-cotton.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a thin attendance on 'Change, little business was done, but the prices were firm as quoted last week. Makers being heavily sold, and finding the demand excellent are sanguine that there will be a further advance of prices. The returns of the Cleveland Ironmasters' Association showing the make during July were not satisfactory. The total make of pig iron by 121 blast furnaces amounted to 158,126 tons, an increase of 12,905 over the same amount last year. Makers' stocks only amounted to 91,086 tons. Considering the position of the trade it would not be surprising if prices were increased during the next few weeks.

The Finished Iron Trade.—There is great activity in every department of the finished iron trade. The rail mills are all busy on contracts made some time ago, and orders are still coming to hand. To-day the Stockton races are being held and a large number of the men in the iron works are making a holiday. The races extend over to-morrow and Friday, consequently the make in the various mills will this week be considerably below the usual output.

New Works.—There are no fewer than fourteen new blast furnaces in course of construction on Tees-side. Messrs. W. Whitwell and Co., South Stockton, are making the foundations for two new furnaces. The Marton Iron Company, which was formed a month or two ago, have purchased a site near Coatham, and will begin without delay to erect two blast furnaces.

Middlesbrough and the Railway Accommodation.—Although the scheme proposed by the North-Eastern Railway Company for crossing the Tees at Middlesbrough by a swing bridge and improving the railway accommodation between the Hartlepool coal field and the iron producing district of Cleveland was lost when before Parliament this year, the people interested in the trade of Middlesbrough are still alive as to the necessity of greater railway facilities between Durham and Yorkshire. Yesterday Mr. Ogreeon, of Sunderland, read a lengthy paper at the meeting of the Middlesbrough Chamber of Commerce, showing the necessity for improved railway communication between the north-eastern portion of the county of Durham and the district around Stockton and Middlesbrough. An influential committee was appointed to obtain information on the subject, and to co-operate with any parties interested in improving the railway accommodation so much needed.

The Nine Hours' Movement.—There are still no indications of either masters or men in the engineering trade at Newcastle giving in. The men on strike have left the town in small batches week after week, and now the number receiving support from the League is 2341. The amount paid to each man this week is 5s. 0d. Last week the attempt of the masters to induce men from Scotland to work at the factories in Newcastle signally failed; the men brought to the Tyne having returned to Dundee. We stated last week it was the intention of the masters to import foreign workmen. On Monday a meeting of employers was held in London, and it was resolved to bring over 2000 engineers from the Continent at the joint expense of the employers. It is stated, however, that the men have agents in Belgium and other places informing the operatives of the state of matters in the engineering trade at Newcastle and urging them to agitate for additional wages in their own countries. Yesterday a large number of men arrived in Newcastle from London and were apportioned to the different factories.

Shipbuilding.—On the Tyne, Wear, and Tees, all the ship builders are exceedingly busy. As soon as a vessel is launched the frame of a new steamer is seen upon the vacated slip way. At the various yards there are orders on the books which will keep the whole of the hands at present engaged fully employed for months to come.

BRAZILIAN TELEGRAPHY.—About 1300 miles of telegraph have now been constructed in Brazil by the Brazilian Government, viz., from Rio to Porto Alegre, from Rio Grande to Pelotas, from Rio to Pontal, from Rio to Cafe Frio, from Paranagua to Coritiba, &c. A line to Pernambuco, which is about to be made, will be about 1250 miles in length, and will cost 92,800*l*. The financial results achieved thus far upon the Government telegraph lines do not appear to have been thus far very brilliant. The Government secures, however, the free transmission of a large number of official telegrams. Private telegraphic correspondence appears also to be slowly increasing in Brazil.

OUR NAVY.—The following iron and armour-plated men-of-war are at the present time under construction for the Government in Her Majesty's dockyards and by contract: The Fury, armour-plated turret ship, 4 guns, 5030 tons and 1000 horse power engines, building at Pembroke; the Blonde, iron steam frigate, cased with wood, 26 guns, 4089 tons, 1000 horse power engines, building at Portsmouth; the Thunderer, armour-plated turret ship, of 4 guns, 4406 tons, and 800 horse power engines, building at Pembroke; the Rupert, ironclad ram, 4 guns, 3159 tons, engines of 700 horse power, building at Chatham; the Gorgon, double screw iron armour-plated turret ship, 4 guns, 2107 tons and 250 horse power engines, building at Jarrow-on-Tyne; the Raleigh, iron frigate sheathed with wood, 22 guns, 3210 tons, and 800 horse power engines, building at Chatham Dockyard; the Hecate and Hydra, double screw iron armour-plated turret ships, of 4 guns, 2107 tons, and engines of 250 horse power each, building at Poplar and Glasgow; the Frolic, Kestrel, Ready, and Rifleman, double screw composite gun vessels, of 4 guns, 462 tons, and 100 horse engines each, building at Chatham.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The return of shipments from Scotch ports for the last week is again very good for this time of the year, being: foreign, 14,732 tons; coastwise, 5478 tons; total, 20,210 tons. Same week last year, 8338 tons; increase for week, 11,872 tons. Total shipments for 1871, 506,554 tons; same date last year, 389,259 tons; total increase of shipment, 117,295 tons. The Board of Trade returns for last month show that the total quantity of iron and steel exported from Great Britain to 31st July, 1871, was 1,752,432 tons; at the same date last year there were 1,738,629 tons exported. From these figures it will be seen that there is upwards of 13,000 tons of an increase in our exports of iron as compared with the similar date last year, showing the gradually advancing improvement in this branch of trade, as, at the end of June, the return showed a decrease in exports as compared with the same date last year of 40,000 tons. The stock of iron in store in Glasgow, at 31st July, 1871, has been reduced since the same date last year by 47,767 tons. 200 tons of iron went into store yesterday, and there may be a small lot more to-day, but this is counterbalanced by the quantity sent out during the month. Makers of special brands are hardly sellers just now. The following are, however, the nominal quotations: Gartsherrie, No. 1, 72s. 6d.; No. 3, 62s. 6d.: Coltness, No. 1, 72s. 6d.: No. 1, 62s. 6d.; Summerlee, No. 1, 69s.; No. 3, 62.—f. o. b. at Glasgow; Langloan, No. 1, 65s.; No. 3, 63s., 6d. extra at Glasgow; Carnbroe, No. 1, 64s.; No. 3, 61s. 6d., 6d. extra at Glasgow; Ardeer and Glengarnock, No. 1, 66s.; No. 3, 61s.—f. o. b. at Androssan; Kinneil, No. 63s.; No. 3, 58s.—f. o. b. in the Forth. Messrs. Laidlaw and Sons have secured the contract for all the pipes and gas-lighting apparatus for Yokohama. They are very full of orders, and there is a better feeling as to future prospects amongst the other large iron-founders. There is rather more inclination within the last few days amongst the bar iron merchants to buy forward, but makers are stiff in their prices. A little fluctuation in prices has occurred during the past week. This day week 60s. 11s. to 61s. 3d. cash, and 61s. 3d. to 61s. 7d. one month, were the prices paid; and on the two following days the advance continued, the market closing on Friday at 62s. 4½d. cash, and 62s. 7½d. one month. On Monday 62s. 9d. cash, and 63s. one month were paid for many lots. There was a decline in the cash price yesterday to 62s. 1½d., the month price being nominally 62s. 6d. To-day's market opened flat, the cash price was down at 61s. 10½d., but the tone improved, and yesterday's prices were accepted. The high prices lately obtained for pig iron have apparently stimulated the furnacemen and others to seek an advance of wages. A number of furnaces have been damped down at one establishment where an advance of ¼d. per ton has been asked by the workmen.

A Class for Instructing Ploughmen in the Use of the Steam Engine.—For a considerable time it has been in contemplation to form a class of ploughmen at Fordoun Station to communicate a knowledge of steam and the management of the steam engine. In March last two or three meetings were held in the market booth of Fordoun, when Mr. Crabb, schoolmaster, Waterlair, lectured to considerable meetings of young ploughmen on steam, and the elements of mechanics. The ladies of the district have worked, and purchased a small steam engine of half a horse power for the purpose of illustrating a contemplated course of lectures next winter, and last week the committee received two small model steam engines, with plough, grubber, and complete set of tackle, from Messrs. Fowler and Co., Leeds, for the use of the class. Mr. Greig, Harvieston, and Mr. Curror, secretary to the Scottish Chamber of Agriculture, are taking a deep interest in the class. Young farmers and young ploughmen are specially requested to attend, as it is entirely for their benefit and improvement that the class is to be conducted. A good many Kincardineshire men could be named who are now earning 200*l.* or 300*l.* a year who have risen from the plough-tail during the last ten years. If the class is well supported during the ensuing winter, it may enable many to follow their example.

Glasgow and Suburban Tramways.—The Corporation of Glasgow are about to commence the construction of some nine miles of street tramways, and are advertising for offers for the necessary works. In order to form connexions between them and certain towns and mining villages to the east of Glasgow, a new company has been projected, called the Glasgow, Bothwell, Hamilton, and Wishaw Tramways Company, with a capital of 110,000*l.*, in 11,000 shares. The provisional directorate includes a number of gentlemen who are connected with the extensive coal-fields and ironworks in the neighbourhood of the proposed tramway line and its branches. The length of the lines proposed is about nineteen miles.

Appointment of Engineer for the Edinburgh Tramways.—At a meeting of the Edinburgh Town Council, yesterday, Mr. Hugh C. Bell, C.E., was appointed engineer for the tramways now in course of construction in the Scottish metropolis. Mr. Romanes, C.E., member of the Town Council, was a candidate for the appointment, but he withdrew, and the only other candidate who was nominated was Mr. Masterton, who received fourteen votes against seventeen given to Mr. Bell.

New Engines for the Glasgow Fire Brigade.—Two new engines, supplied by Messrs. Shand, Mason, and Co., of London, have just been added to the plant of the Glasgow Fire Brigade. They are very excellent specimens of their kind, and the result of a trial made this week has proved that they possess all the necessary qualifications for doing their work expeditiously and well.

Partick, Hillhead, and Maryhill Gas Company.—The efforts made to establish a gas manufacturing company in these suburbs, to be independent of the Glasgow Corporation gas authorities, are making some show of progress. Hitherto the suburban burghs named above have been supplied from the Glasgow gas mains. Ground extending to about six acres, and lying between the Forth and Clyde Canal and the line of the new Stobcross Railway, has been secured for the works. Instructions have been given to Messrs. Forman and McCall, civil engineers, Glasgow, to prepare plans and specifications for a siding from the railway into the works; and the manager, Mr. James Hislop, late manager of the Ayr Gas Company, is about to prepare plans and specifications for the works, which are expected to be in operation at Whitsunday next.

Parliamentary Vote for Anstruther Harbour.—Among the votes taken in supply in the House of Commons on Saturday last, was one of 7000*l.* for the harbour of Anstruther in Fifeshire.

Advance of Miners' Wages.—The miners in the district of Maryhill, near Glasgow, have for several weeks been engaged in carrying on an agitation for an advance of wages. Their efforts for a time collapsed, but they were lately renewed and a strike resulted, as the employers would not grant any advance. The strike only lasted for two or three days, and last week the Jordanhill men, who were the prime movers, received intimation of an advance of sixpence per day being granted. When the men at the other collieries conveyed the information to their respective employers the advance was very generally conceded.

The Government and Scientific Education.—I understand that an eminent scientific gentleman, who is a member of the Royal Commission on Scientific Education, has recently visited Glasgow for the purpose of inquiring regarding the facilities which the city offers for being the seat of one of the local science colleges, which, it is understood, the Government is disposed to establish in such important industrial centres as require and are desirous of having them. He inspected the internal arrangements and scientific apparatus in Anderson's University, which may be regarded as the parent of the mechanics' institutions now so numerous throughout the country, and expressed himself much pleased with the same.

Large Iron Water Wheel.—A high-breast water wheel, 40 ft. in diameter and 10 ft. in width, constructed entirely of iron, has been made by Messrs. Thomson, Brothers, and Co., Douglas Foundry, Dundee. The outside rings are suspended by radial and diagonal rods from strong cast-iron centres keyed in a wrought-iron axle. There is no centre ring, the buckets and soleing being in one width. There are 80 buckets stayed to each other by wrought iron. The power is taken from the wheel by an internal toothed wheel nearly the diameter of the water wheel, and bolted to its shrouding.

New Line of Steamers for the Cardiff and New York Trade.—Messrs. William Simons and Co., London Works, Renfrew, are building several vessels for the South Wales Atlantic Steamship Company, a company which has recently been formed for the purpose of running a line of steamers between Cardiff and New York. Mr. C. R. M. Talbot, M.P. for Glamorganshire, who, with the Marquis of Bute, and other influential gentlemen, has a deep interest in this project, visited the Clyde last week in his steam yacht, Lynx, formerly one of Messrs. Burns' Glasgow and Liverpool fleet, and inspected the vessels being built by Messrs. Simons and Co.

NOTES FROM THE SOUTH-WEST.

Llynvi Railway.—The improvement in the traffic receipts of this company enables the directors to declare a dividend at the rate of 3 per cent. per annum on the ordinary stock for the first six months of this year. The works of the line from Black Mill to Hendreforgan on the Ely Valley extension line have progressed slowly, owing to delay in the acquisition of the necessary land. The directors having, however, now secured possession of most of the land needed, the construction of the link will be pushed on with vigour.

Trade at Newport.—The quantity of coal exported from Newport in July to foreign ports was 33,877 tons; the quantity exported coastwise was also 65,969 tons. The total quantity of pig, bar, and railway iron exported from Newport during July was 11,800 tons, of which 1557 tons went to Buenos Ayres, 1000 tons to New Orleans, 4231 tons to New York, 1238 tons to Portland, and 1150 tons to Talcahuano. The iron trade remains fairly active. Steel rails command an increasing sale, and it appears to be thought that, even if the make were largely extended, no difficulty would be experienced in securing additional contracts.

Monmouthshire Railway.—This line has begun the current half year well. In five weeks the receipts were 17,634*l.* against 15,009*l.* in the corresponding period of 1870.

State of Trade at Merthyr.—The state of the iron trade about Merthyr Tydfil continues satisfactory, good orders being on hand both on American and Canadian account. Considerable shipments of rails have been made to Montreal, a fair export trade has also been done in bars. The coal trade about Merthyr displays a fair amount of activity.

Great Western Railway.—The directors of this company have agreed to lay down the narrow gauge from Didcot over the whole of the company's system in South Wales.

American Steamers from Cardiff.—Messrs. Simons and Co., of Renfrew, are now engaged upon some steamers for the South Wales Atlantic Steamship Company, which was recently formed for the purpose of running a line of steamers under the management of Mr. Laughland between Cardiff and New York. The Marquis of Bute, Mr. C. R. M. Talbot, M.P., and other gentlemen are largely interested in the company.

Taff Vale Railway.—The balance of net profit realised by this undertaking, for the six months ending June 30, was 105,907*l.*, of which 38,203*l.* was absorbed by debenture and preferential charges. In the corresponding period of 1870 the corresponding balance of profit was 110,266*l.*, of which 38,824*l.* was absorbed by debenture and preferential charges. The doubling of the line between Ystrad and Trcherbert in the Rhondda Valley has been completed.

Newport Gas Company.—The renewal of one of the gasholders of the Newport Gas Company has been nearly completed. Important repairs are required to be carried out in another of the gasholders, and are now being examined by the company's engineer.

South Wales Steam Coal Trade.—The strike among the steam coal colliers of South Wales has lingered on, but the production appears to be reviving to some little extent notwithstanding. This strike has been a lamentable affair alike to employers and employed. It is deeply to be desired that some satisfactory adjustment could be secured of the miserable strife, and this adjustment seems likely to be now effected by means of arbitration.

Welsh Shipping Movements.—The John Wesley has cleared from Cardiff for Hamburg with 160 tons of railway iron supplied by the Dowlais Iron Company. The Alice M. Minott has cleared from Cardiff for New York with 1460 tons of railway iron supplied by Mr. R. Crawshay. The Margaret, screw steamer, has cleared from Cardiff for Trieste with 800 tons of railway iron supplied by the Rhymney Iron Company. The Uzziah has cleared from Cardiff for Smyrna with 311 tons of bar iron, supplied by Mr. W. Crawshay. The Warwickshire has cleared from Cardiff for Pisaqua with 950 tons of railway iron supplied by the Aberdare Iron Company. The Regina has cleared from Newport for Galveston with 750 tons of iron supplied by the Ebbw Vale Company. The Hertig Oscar Fredrik has cleared from Newport for Buenos Ayres with 815 tons of iron. The Wetterhorn has cleared from Cardiff for Mobile with 976 tons of railway iron supplied by Messrs. Guest and Co.

Newport Alexandra Docks.—It is now generally understood that the Great Western Railway Company will subscribe towards the completion of the Alexandra Docks at Newport. The docks will probably prove very convenient for the Great Western, especially in connexion with the Aberdare coal traffic.

Midland Railway.—In the half-year ending June 30, the Midland Railway Company expended 10,566*l.* in the construction of a new goods' shed and sidings at Cheltenham. A sum of 1052*l.* was expended on a new coal-shed and sidings at Gloucester; and 1927*l.* was devoted to a new goods' shed, coal wharf, and sidings at Bristol. The great system of the Midland is steadily growing in all directions.

Forest of Dean Iron Company.—This company has put in blast a new furnace at Parkend. The furnace, which is fitted with all the most improved appliances, will enable the company to considerably increase its production of iron The demand for Forest iron is very active, and exceeds the supply.

State of Trade at Swansea.—The principal iron works at Swansea are fully occupied in the execution of orders which have been on their books for some little time. Additional contracts also continue to come to hand. The demand which prevails is principally on American and continental account, the home trade not being very active.

The Severn.—The Gatcombe-bridge scheme has been revived, being promoted by a company taking the name of the Western Junction Company. The place at which it is proposed to span the Severn is regarded as a convenient one from a Forest-of-Dean point of view. Little difficulty is expected to be experienced on the western side of the estuary in connecting the bridge with the new docks, the Midland Railway for London, &c.

The Gnoll Collieries.—An engine of 200 horse power has been erected for the purpose of removing water from the Gnoll collieries. The engine has been put in operation, and has worked extremely well.

South Wales Coal and Metal Markets.—A market was held on Saturday at Swansea. There was only a moderate attendance, and but little business of importance was transacted. An advance of 2s. 6d. per ton was, however, established in No. 3 hematite iron, and prices appear to be still tending upwards. Mr. Roberts, representative of Mr. C. D. Philips, of Newport, showed some samples of lubricating oils and a new patent can, and universal steam pump.

FULLY DEVELOPED TRADES' UNIONISM.—The *Times* says, "San Francisco advices intimate that although, 'if there be any part of the earth where trade union outrages are more hideous and inexcusable than elsewhere, it is California; the worst features of the evil are to be witnessed in that state. At the Amador mines the hands are on strike, 'and have taken to murdering their employers.' In their latest attack they had killed the bookkeeper, and their purpose seems to be 'to murder the officers and others in charge of the mine, to take possession of it themselves, and run it for their own benefit on the communistic plan.' Until lately a battalion of California militia had been protecting the property, but on a solemn pledge on the part of the strikers to be peaceable, this force was withdrawn. 'Hardly, however, were the soldiers' backs turned when the strikers peremptorily demanded that men not belonging to the union should be discharged by the company, and that men who had been turned off in consequence of the strike should be reinstated. The company refused these conditions —hence the murders.' The New York papers, commenting on this development, remark that it will be an imperative duty for the governor of the state to march his soldiers again to the mine, 'and enforce order with bullets and bayonets, and cause the arrest and speedy trial of the assassins.'"

RECENT PATENTS.

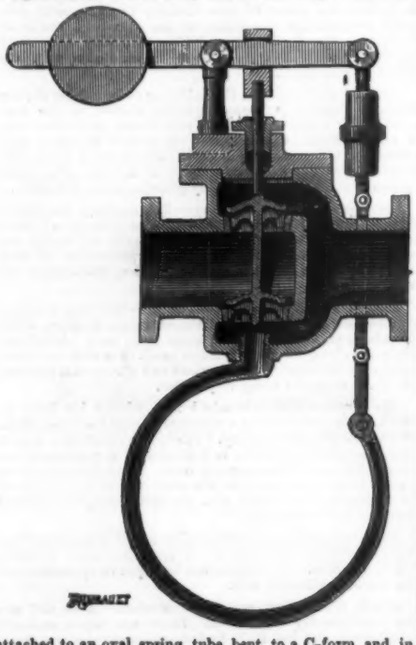
THE following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 2299, 10d.) Joseph Whitehead Broadbent, of Oldham, patents arrangements for removing the scum from steam boilers. According to one arrangement included in these plans the scummer is made of two plates secured together parallel to each other with a space between them. The lower of these plates carries a slab of baked clay, or similar material, while the upper one is flanged obliquely upwards around its periphery, and is connected by an arrangement of jointed pipes, with an external discharge pipe, having a scum cock as usual. The plates and clay slab are balanced by a counterweight and they thus form a combined float and scummer, the scum reaching the discharge pipe through the opening between the top of the clay slab and the underside of the top plate. It will be seen from what we have said that the arrangement enables the scum to be blown off with the water at any level.

(No. 2305, 1s. 6d.) Richard Christopher Rapier, of 5, Westminster Chambers, patents an arrangement of locking apparatus for railway switches and signals, which possesses many good points and which we hope on a future occasion to describe fully.

(No. 2307, 3d.) Charles Frederic Collan, of Wheal Zion, Cornwall, patents arrangements of ore dressing machinery which it would be impossible for us to describe briefly.

(No. 2315, 10d.) Squire Farron, of Ashton-under-Lyne, patents arrangements of reducing valves. According to these plans the steam is made to pass an equilibrium valve, the spindle of which passes through a stuffing box and is coupled to a loaded lever, this lever being in its turn



attached to an oval spring tube bent to a C-form and, in fact, resembling the tube of a Bourdon pressure gauge. This tube is exposed internally to the pressure of the steam which has passed the valve and any increase in that pressure tends to straighten the tube, and thus by closing the valve reduces the pressure to its normal amount. The annexed sketch will explain this arrangement—which appears a promising one—more clearly. The only point on which we feel doubtful is the influence of the stuffing-box friction.

(No. 2321, 10d.) John Robinson and John Smith, of Rochdale, patent machinery for cutting wood for manufacturing paper pulp. We cannot describe this machinery in detail here; but we may state that its main features consist in the employment of combined cutters and lancing instruments, the revolving cutter blocks carrying these tools being disposed so that the periphery of one overhangs that of the other.

(No. 2330, 7s.) William Edward Newton, of 66, Chancery-lane, patents, as the agent of Richard March Hoe, of New York, various improvements in the construction of printing machinery. This is an important specification; but it is far too voluminous for us to give an account of its contents.

(No. 2332, 8d.) Isaac Brown, of Elm Croft Grange, Edinburgh, patents the manufacture *in situ*, by means of a portable lead pipe press, of thin lead pipes suitable for irrigation purposes, the pipes thus made being laid as they issue from the press. The object of these plans is to avoid the difficulties attending the transport of thin lead pipes of 2 in. or 2½ in. in diameter, and at the same time to enable the pipes to be deposited in long lengths without joint.

(No. 2334, 1s. 8d.) Alfred Alexander and David Lansley, of Cirencester, patent arrangements of feed-water heaters for portable engines. According to these plans the feed water on its way to the boiler is pumped through an annular casing surrounding the smokebox, or in some cases forming the latter, this casing being in free communication with the boiler. We see nothing new in these plans. The patent also includes an arrangement of pump valves for enabling the feed to be sent through the heater or into the boiler direct, at pleasure.

(No. 2335, 8d.) Henry James Hogg King, of Glasgow, patents an arrangement of feeding apparatus for carding engines. The main features in this arrangement consist in applying a backwardly revolving paddle combined with a vibrating finger plate for distributing or equalising the fibrous materials on the feed apron, while a vibratory motion is also imparted to the board or plate over which the materials fall upon the apron.

(No. 2349, 10d.) Thomas Frederick Henley, of Pimlico, patents the arrangement of tunnelling machine illustrated and described by us on pages 22 and 23 of our last volume. We notice that our description of this machine has been embodied in the specification of the patent, and in fact the specification consists of but little else.

STEAM BOILER LEGISLATION.

Second Report of the Committee appointed to consider and report on the various plans proposed for Legislating on the subject of Steam Boiler Explosions, with a view to their Prevention, the Committee consisting of Sir William Fairbairn, Bart., C.E., LL.D., F.R.S., &c., John Penn, C.E., F.R.S., Frederick J. Bramwell, C.E., Hugh Mason, Samuel Rigby, Thomas Schofield, Charles F. Beyer, C.E., Thomas Webster, Q.C., and Lavington E. Fletcher, C.E.

SINCE the first report on the subject of "Steam Boiler Legislation" was presented to the meeting of the British Association, held last year at Liverpool, the Parliamentary Committee "appointed to inquire into the cause of Steam Boiler Explosions and the best means of preventing them" have presented their report.

The consideration of the result of the Parliamentary Committee's inquiry clearly becomes one of the most important duties in reporting to the British Association on "the various plans proposed for legislating on Steam Boiler Explosions, with a view to their Prevention." Unfortunately, however, the Parliamentary report has been so recently published that there has not been time for its due consideration, or for the committee appointed to treat on this subject to meet and confer thereon. Under these circumstances it has been thought best not to attempt to enter upon the subject on the present occasion; but to postpone doing so until next year, after having an opportunity of watching the development of the measure, and its working when carried into actual practice; and therefore, in order that they might be in a position to report thereon to the next meeting of the British Association, the committee would beg to suggest their reappointment.

(Signed on behalf of the Committee),
WILLIAM FAIRBAIRN, Chairman.
Manchester, July 27, 1871.

PRIVATE BILLS IN PARLIAMENT.

DURING the present week two more batches of Private Bills have received the Royal assent. Those on Monday were the Metropolitan Tramways Provisional Orders Suspension, the Sewage Utilisation, the Tramways Provisional Orders Confirmation, the Lyme Regis Railway, the North and South-Western Junction Railway, the Harrow, Edgware, and London Railway, the Mersey Dock and Harbour (No. 2), the Midland and Great Eastern (Alexandra Park Branch) Railway (New Alexandra Park Railway), the West Lancashire Railway, the Mersey Railway, and the Euston, St. Pancras, and Charing-cross Railway. The Commissioners were the Duke of St. Alban's, the Marquis of Aylesbury, Viscount Halifax, and Lord de Tabley. On Wednesday the London and Aylesbury Railway Bill received the Royal assent, the Commissioners being the Lord Chancellor, the Marquis of Ripon, and Viscount Halifax.

ANOTHER THAMES SUBWAY.—A prospectus has been issued of the Southwark and City Subway Company, with a capital of 100,000*l.* in shares of 10*l.*, for making an underground subway from St. George's Church, in the Borough, to Arthur-street, on the City side of London Bridge, on the principle already carried out in the Tower Subway, which passes under the Thames between Southwark and Tower-Hill.

ON AN AUTOMATIC DISCHARGE GAUGE.*

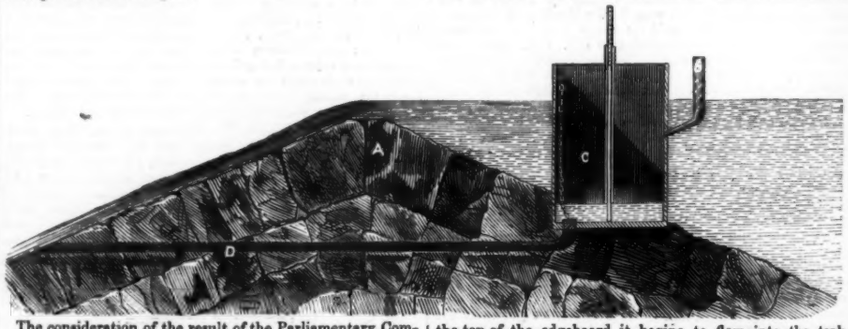
By THOMAS STEVENSON, F.R.S.E., M.I.C.E.

NEXT in importance to a knowledge of the rainfall of any district of country is the determination of the constant for absorption and evaporation. While the actual amount of rainfall is doubtless of value in meteorology, it is the available rainfall, or that which passes off the land which is required to be known in all cases of water supply; and it has also an important bearing on the subject of agriculture. This quantity varies with different localities, depending on the geological formation, the nature of the vegetation, and steepness of the slopes of the hills and mountains.

If a reservoir were of sufficient capacity to store up the whole of the available annual rainfall due to a given catchment area, we should then be able to obtain the required constant with perfect accuracy. This, however, probably exists nowhere, for in all reservoirs for the supply of towns a large quantity of water passes off by the waste weir or edgeboard, which is placed near the top of the embankment. The usual mode of ascertaining the quantity thus going to waste is by measuring once or twice a day during floods the level of the water above the top of the edgeboard, from which, by means of well-known formulæ, the quantity passing off is easily computed. It must be obvious that from such limited observations the quantity going to waste can only be very approximately ascertained, for the level of the water in the reservoir during floods is liable to great fluctuation.

Self-registering apparatus for indicating the variations in level, with the periods corresponding to such variations, might be formed by a float connected with a marker acting on a cylinder moved by clockwork. Another, and probably a simpler apparatus, was referred to by me at the last meeting of the Scottish Meteorological Society. Since then the details of the proposal have been drawn out and will now be described. A represents a cross section of a reservoir taken through the waste weir. B is a pipe perforated with small holes like a rose, the lowest hole in which is placed on the same level as the top of the edgeboard. A tube connects this with the tank, C, which has a float with graduated rod, and from this tank a pipe, D, with waste valve, is led through the waste weir.

Whenever the water in the reservoir rises to the level of



the top of the edgeboard it begins to flow into the tank through the lowest perforation, and as the water rises it will pass through more of these holes, and thus the water which flows into the tank will remain a constant submultiple of what flows over the weir, and can be read by the sluice-keeper on the graduated rod. After the height of the float is read off the tank is emptied by opening the waste valve, when the water will escape over the down-stream side of the embankment, and the float will sink to zero on the graduated stem. The values of the readings on the graduated stem must be found experimentally before the instrument is used by the immersion in water of the perforated tube at different levels, so as to ascertain the quantity passing through the holes at different levels of immersion. In order to prevent dust from choking up the small orifices, a protecting tube should be placed over the rose tube. In a properly constructed reservoir the length of the waste weir should be so designed as never to have a greater height of water than 1 ft. or 18 in. passing over it in heavy floods, so that the perforated tube need not be longer than about 18 in. The capacity of the tank must be proportioned to the size of the perforations in the tube (which should be arranged spirally) and the number of hours when the sluice-keeper is absent, which at the maximum will probably be from 9 p.m. to 6 or 7 a.m., which would require about nine or ten hours' storage.

GARRISON POINT FORT.—The new casemated fort at Garrison Point, Sheerness, which is being built for the defence of the River Medway, is rapidly approaching completion. The whole of the granite work was finished some time since, and is now sufficiently firm to allow the arming operations to be proceeded with. About half of the armour plates which are to protect the embrasures have already been fixed, and fourteen of the thirty-eight heavy rifled guns with which the fort is to be armed are mounted. These are 9-inch guns, weighing 12 tons each, and throwing projectiles of 250lb. weight with a force considered capable of penetrating any ordinary ironclad ship at ranges of about 1000 yards. The fort is what sailors term a "two-decker," there being a double tier of guns, nineteen in each tier. It is in shape like the letter D, the round side being armed, and fronting the mouths of the Thames and Medway, and a considerable extent of the seaboard, while the straight part forms the gorge or entrance on the land side, and is unarmed.

* Paper read before Section G of the British Association.

BAUSCHINGER'S INDICATOR EXPERIMENTS ON LOCOMOTIVES.

(*Continued from page* 84.)

WE must now again refer to page 18 of the present volume, where the valves, together with the arrangements of the eccentrics and gear belonging to engines A, B, C, and D, are illustrated; we should, however, in the first place, correct an error which has occurred in scaling some of those figures distinguished by the affix *a*. The scale, namely, of Figs. 1 *a*, 2 *a*, and 3 *a*, is 3 in. to the foot, and that of Fig. 4 *a*, 1½ in. to the foot, instead of ¾ in. to the foot, as stated. As we have already mentioned, in describing the various engines (see Table I., on page 1), engines A and B are of exactly identical dimensions, except throw of eccentrics and lead, but, as will be noticed, on page 18, the valve of engine B is also provided with less inside lap than is the case in engine A. Owing to this circumstance, the pre-release of engine, B, as shown by the Table on page 83 of our last number but one, is considerably greater than in the former engine; it is still more in engine C, while in the case of the fourth engine, D, the valve was unequally set, so that the amount of pre-release was, of course, also unequal at the two ends of the cylinder. The two degrees of expansion, corresponding to the numbers of "notch" given in our Table, are for the four engines about the same, the point of cut-off being in one case at from 50 to 60 per cent., and when cutting off short from 22 to 25 per cent. of the length of stroke. The indicator experiments on these engines show—as we have already stated—that with ample premature release, the back pressure becomes reduced to an almost imperceptible amount; also that a good pre-release is especially valuable at high speeds. In this respect, the curves taken from engine B, compare very favourably with those of engine A. It is, in fact, the good results obtained with the former engine, particularly when working express traffic, which have led Professor Bauschinger to the conclusion that inside lap may be dispensed with in the shifting link motion. With this we agree, as an ample opening for the escape of the steam at the end of the stroke, is of great importance, and with a link motion of normal proportions, the outside lap of the valve assures quite a sufficient amount of compression.

We will next examine the striking effect which is produced on the back pressure by a combination of circumstances, and which is common to most engines fitted with a single blast pipe; diagrams Nos. 17 and 18 on page 52 show the effect referred to. Instead of continuing in a straight line to the beginning of compression, the back pressure line is marked by several rises and subsequent falls which cause a considerable deviation from its original level, and involve, of course, a corresponding loss of effective pressure. This condition must be attributed chiefly to the influence of the exhaust of one cylinder on that of the other cylinder, and its varying effect depends in its turn upon the form of the union pipe, the pressure of the steam at the beginning of the discharge, the amount of pre-release, and, finally, upon the nature of the discharge pipe and nozzle. In all cases, where both cylinders discharge their steam through the same blast-pipe, the cylinders are, at certain parts of the stroke, more or less in direct connexion with each other, so that the exhaust steam issuing from one cylinder causes an additional back pressure in the other at about the middle of its stroke.

FIG. 21

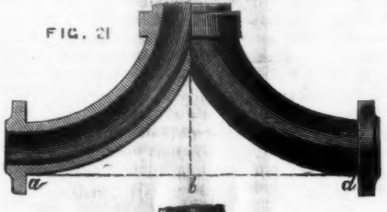


FIG. 22

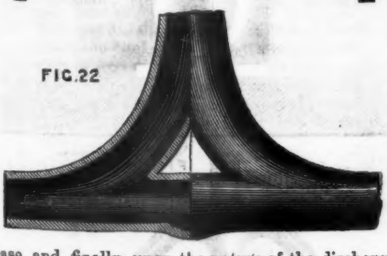


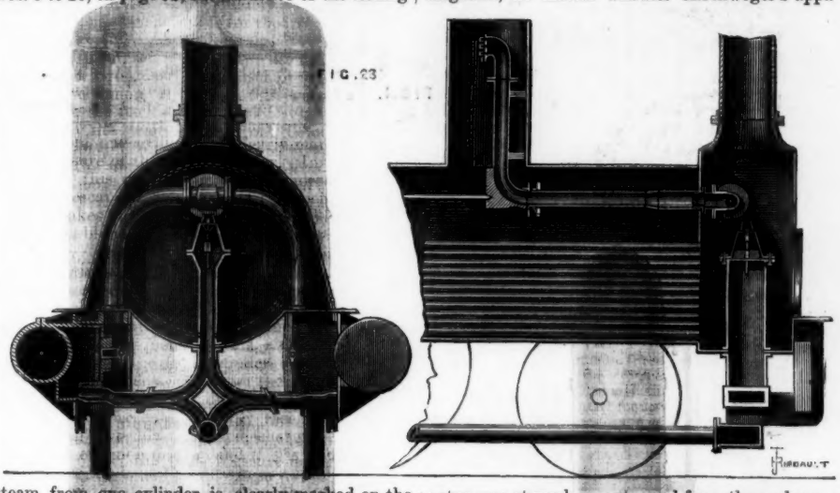
Fig. 21 illustrates the manner in which, in engines A and B, the steam from the two cylinders is discharged into the blast pipe, while in diagrams, Nos. 5 to 10, on page 52, the influence of the issuing steam from one cylinder is clearly marked on the back pressure of the other cylinder. In the case of engine B, this peculiarity is still more apparent, since the escape of the steam at the opening of the exhaust takes place more rapidly and producing thus a vigorous blow, as it were, from one cylinder into the other. In engine G, the two cylinders discharge their steam as illustrated in Fig. 22. This engine, we should state, was formerly provided with a condensing arrangement so that the exhaust was conducted by means of a branch pipe into the tender. In consequence of this, a direct communication between the two cylinders was established, which circumstance accounts for the irregularities of the back pressure lines of diagrams Nos. 17 and 18. Engine H represents the only case of an engine fitted with two blast pipes, discharging, however, through a common orifice, and this is also the only case where the back pressure in one cylinder is not affected by the steam issuing from the other. It is certainly not difficult to devise proper arrangements, whereby the unfavourable influence of one cylinder on its neighbour can be neutralised; the steam may be either discharged by means of two separate nozzles as frequently employed by the Americans, and to which arrangement, the case of engine H just mentioned, presents the nearest approach, or a single blast pipe can be so shaped that the two discharges are kept distinct until they are close to the blast pipe orifice.

As we formerly stated, most of the engines of the Bavarian State railways are fitted with an arrangement by means of which the area of the exhaust nozzle can be changed within certain limits, a contrivance which is very useful for producing a more vigorous draught in the boiler. On the other hand, a reduced area of the blast orifice will also materially affect the back pressure in the cylinder, since a greater effort is necessary to effect the discharge of the steam. The effect of varying areas of the exhaust nozzle on the back pressure in the cylinder, is distinctly shown in the following Table:

Class of engine.	Reference number to diagrams on page 52.	Speed. In revolutions per minute.	Speed. Speed of piston in feet per minute.	Opening of blast nozzle. In parts of total opening.	Opening of blast nozzle. In per cent. of cylinder area.	Pressure at beginning of release in pounds per square inch.	Minimum back pressure in pounds per square inch.	Minimum back pressure in per cent. of pressure at beginning of release.
A	7	94	378	open	9.4	58	3	5.2
	5	84	336	½ shut	7.8	52	3	5.7
	6	79	318	⅓ "	6.2	58	8.5	14.6
	8	94	378	shut	3.0	55	10.5	19.0
G	17	92	366	open	12.2	50	3	6.0
	18	96	384	½ shut	8.3	46.5	9	19.3

In the course of the above trials, Professor Bauschinger also experimented on an engine fitted with Kirchweger's feed-water heater, in order to ascertain its effect upon the back pressure in front of the piston. The indicator, however, did not show any change in the back pressure line of the diagrams, no matter whether Kirchweger's apparatus was at work or not; and from these observations it may be inferred that, as regards the absolute power of the engine, it is indifferent whether the exhaust be discharged through its ordinary channel, or whether it be employed for the purpose of heating the feed water. The manner in which the exhaust steam was taken off for heating purposes in the engine fitted with Kirchweger's apparatus, is shown in Fig. 23.

FIG. 23



WALKER'S FIRE-PROOF FLOORING.

WE need hardly remind our readers that the recent events in Paris have caused the destruction of a vast number of houses, and that consequently there will be plenty of work for architects and builders for some time to come. In order to aid in this work of restoration a French company has been formed for the purpose of building at least a thousand houses in Paris. One of the objects they have in view in the construction of these houses is to render them fire-proof, and we are informed that the principle they have selected is that illustrated in the accompanying engraving. It is the patented invention of Mr. John Walker, engineer, of No. 12, James-street, Old-street, St. Luke's, and it is claimed that it possesses several advantages as a fire-proof floor over ordinary systems. It will be seen that the main bearing girders are of timber measuring about 9 in. by 7 in., enclosed in and strengthened by double angle irons of **Z** pattern. Upon the outer flanges of the angle irons rest the joists, which are

10 ft. long, and are placed about 15 in. apart, centre to centre. The joists are formed of timber battens, 6 in. deep and 1 in. thick, sandwiched between two angle irons of the same depth as the timber. The flanges of the angle irons carry tiles 12 in. square, and formed with a filleting on those parts of the underside which rest on the angle irons. Upon the tiles a bed of concrete, about 2 in. thick, is laid. The timber of the main bearers, and also that of the joists, is rendered non-inflammable before it is worked up. The floor boards are laid upon the joists, the timber of which enables the boards to be attached by nails, as in an ordinary floor. The laths for the ceiling beneath are attached to the underside of the joists in a similar manner, and the fillet on the tiles affords ample space for the keying of the plaster. In this arrangement we have a light yet firm fire-proof floor, embodying many of the advantages of the ordinary timber system, in conjunction with safety in case of conflagration.

BOMBAY HARBOUR.—Permanent defence works in the harbour of Bombay continue suspended, the designs being still under discussion. Some temporary works have, however, been constructed upon the several sites in which the guns recently received have been mounted.

PUMPING ENGINES AT THE BRUNSWICK WATER WORKS.

(*For Description, see Page* 124.)

FIG. 1.

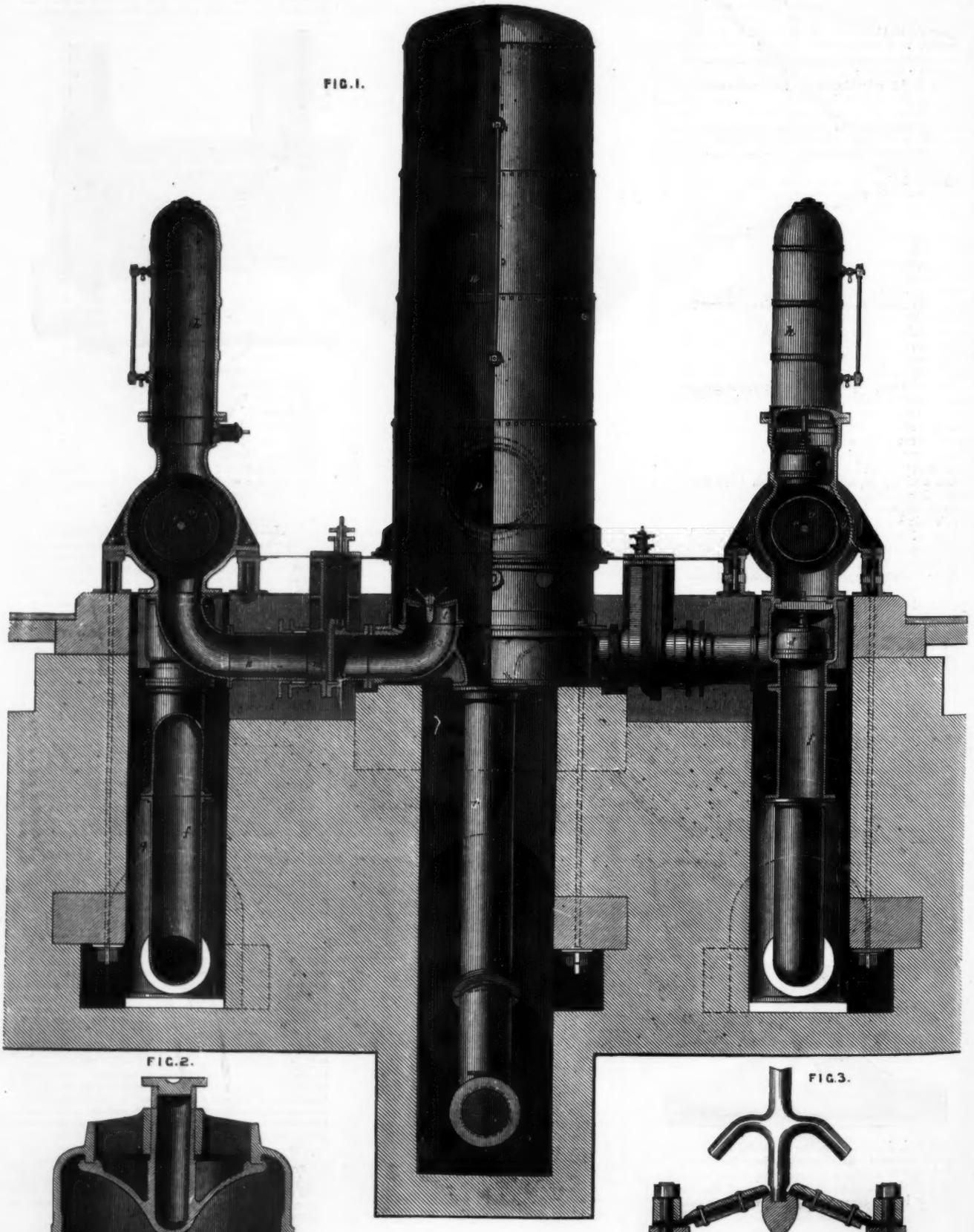


FIG. 2.

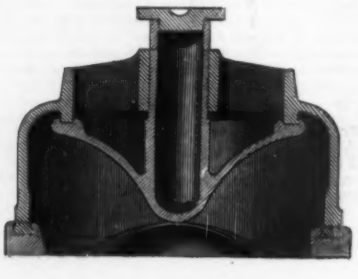
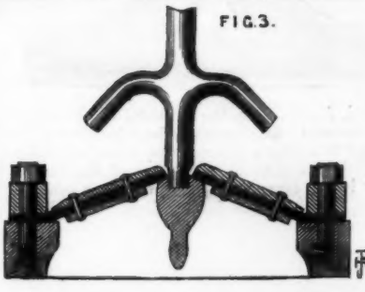
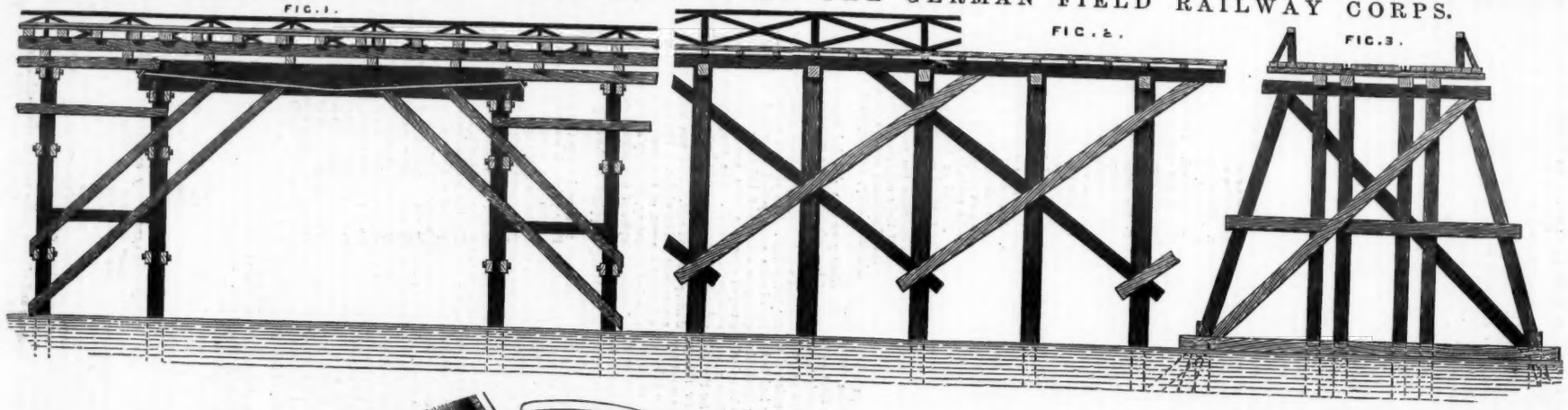
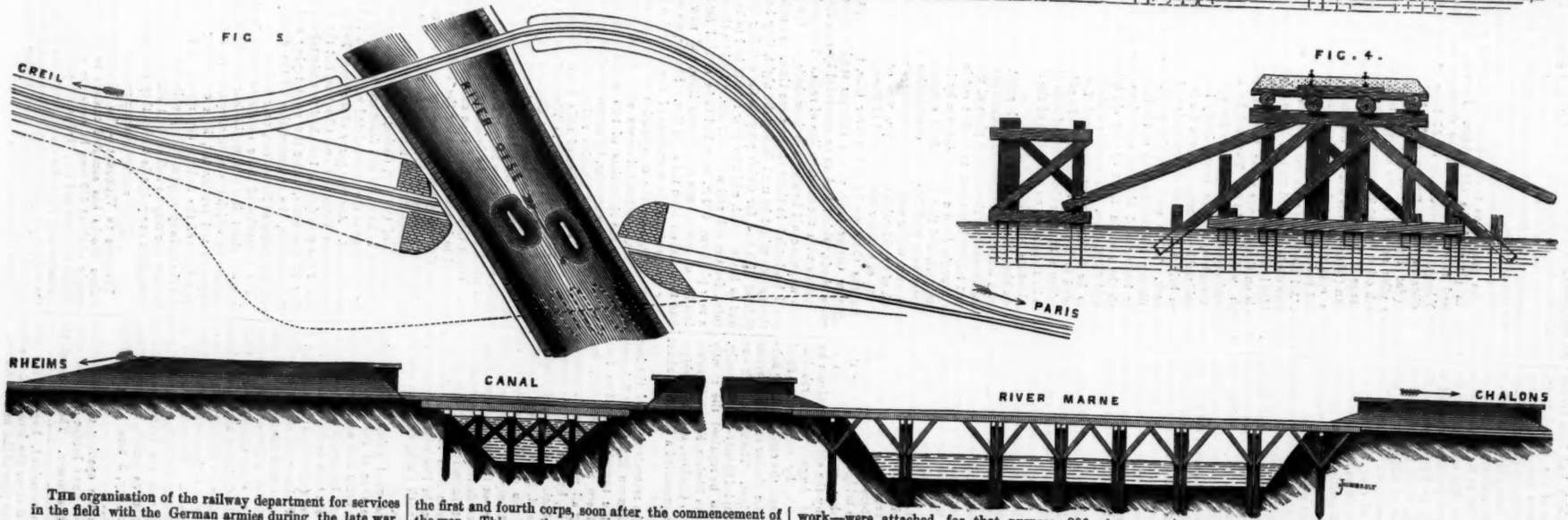


FIG. 3.



TEMPORARY WORKS CARRIED OUT BY THE GERMAN FIELD RAILWAY CORPS.





THE organisation of the railway department for services in the field with the German armies during the late war, consisted of one chief, or general engineer, and the necessary staff for five district or departmental railway corps; four of these corps were attached to the armies of the Northern Confederation, whilst the fifth belonged to the Southern or Bavarian army. M. Hensinger von Waldegg, the chief engineer of the Hanoverian railways, gives in his excellent journal, *Organ für die Fortschritte des Eisenbahnwesens*, an interesting description of some of the operations performed by these corps under the most trying and difficult circumstances.

One of the most difficult problems had to be solved by the first and fourth corps, soon after the commencement of the war. This was the construction of a line from Rémilly to Port-à-Mousson, a distance of about 23 miles (5 German miles), a work which had to be executed in about one month, for the purpose of passing round the fortress of Metz. The railway had to cross two rivers, the Seille and the Moselle, the hills bounding which are, at their lowest points, still about 200 ft. above the valley, while other difficulties, due to the formation of the country, had to be surmounted, especially at Rémilly and Pont-à-Mousson. Notwithstanding all these obstacles, the work had to be done, and to the first and fourth railway corps—which consisted of about 12 engineers, and 450 men trained for railway work—were attached, for that purpose, 800 pioneers, a squadron of cavalry, and a park of about 250 carts, while, besides, all necessary preparations were made for obtaining a corps of labourers of about 3000 men, selected from the miners of the Saarbrück coal district. Not only barracks, kitchens, and magazines had to be built for this army of labourers, but resources had to be discovered from whence could be obtained the enormous quantity of material required for the construction of the railway, and means had to be found to distribute this quantity of material, amounting altogether to about 8000 tons, along the whole line. The work was commenced, with a sufficient number of men, on the 17th of August, 1870, and the last spike was driven on the 23rd of September. The most important works on this line consist of a viaduct near Rémilly, 50 ft. long, and 12 ft. high, a second viaduct between Rémilly and Bechy about 500 ft. long and 23 ft. high, and two timber pile bridges, one over the Seille, 50 ft. long, and another over the Moselle, 280 ft. long. The railway consisted of a single line, 12 ft. wide at the top of ballast, while the greatest incline was 1 in 40, and the sharpest curve had a radius of 600 ft.

Similar works, and not of less importance for the success of the German armies in France, were performed by the other railway corps, of which the second corps distinguished itself by the exceedingly rapid reparation of those

lines in the south-east of France, which had been broken up and destroyed during the retreat of the French army. The Weissenburg-Dunesville line was got into working order by August 19, 1870, and notwithstanding the almost entire destruction of the line from Luneville to Nancy, it was made fit to be used again for military purposes on August 22nd, and that not only as far as Nancy, but even northward over Pont-à-Mousson to Ars, on the Moselle, 2 miles from Metz. But the greatest obstacle remained to be removed on the line from Nancy to Paris, namely, the tunnel at Nanteuil, 944 metres long, which had been blown up by French engineers, by means of mines in the side walls. Not only had the whole masonry structure been completely destroyed for a length of over 30 metres, but also the mountain above it, between 60 and 90 metres high, had been greatly shaken, and had partly fallen into the tunnel, and partly in front of it. The German engineers stated that the destruction had been most frightful.

To clear away this obstacle a great number of miners and labourers were at once called from Germany, and in company with a few hundred carpenters, worked during four weeks day and night, in order to replace the blown-up brickwork by timber framing, when, on November the 9th, the loose portion of the mountain slipped further down, and, breaking several of the strongest beams, made it impossible to proceed with the work. Without any further loss of time, the engineer-in-chief of the railway department ordered the laying down of a new line of rails for carrying the traffic, not through, but around the mountain, and more than 1000 men were soon engaged on this important work, which was executed in twenty-three working days.

Besides the four corps of railway engineers attached to the German armies, an additional corps was formed partly of French railway servants and partly of German soldiers; this additional corps was placed under the command of a German engineer, M. Glaser, who, until the outbreak of the war, had been employed for several years on some of the principal French railways, but who had been expelled from France by the well-known order of the French Government. His services were, of course, at once accepted by the German Government, and he carried out with his corps some of the most important works executed during the war. Two of the chief works executed by M. Glaser were the bridge over the Marne canal, and the bridge over the river Marne itself at Chalons. These two bridges (Figs. 5 and 6 on page 119), as well as the structure for bridging over the marshes between them (the two bridges connected by this structure had been built of timber, and had a length of 5580 ft.) had been burnt down by the aid of petroleum by the French troops on the 27th of August.* The rebuilding commenced on September 9th, by erecting two fixed timber bridges over the Marne and the canal, and by substituting an embankment for the timber structure across the marshes between the two bridges. The whole work was done on October 5th, having occupied twenty-five days only.

At the same time there had to be repaired the greatly damaged lines from Boulzicourt to Rheims, Fismes-Soissons, and from Rheims to Rilly and to Chalons, over the bridges mentioned above; these lines represented a length of about 125 miles.

M. Glaser next undertook the reconstruction of the iron bridge over the Aisne canal, between Rheims and Soissons, as well as the repairing of the tunnel on the line from Rheims to Epernay, the southern portion of which had been blown up. After making all necessary arrangements for the execution of these works, by procuring the required number of workmen, and by obtaining a sufficient quantity of material for bridge and tunnel, M. Glaser was appointed engineer of the railways in the district occupied by the army of the Maas. The first duty was to repair the railway bridge over the river Oise, on the line between Chantilly and Creil, which had been destroyed on September 13 by French troops. The great importance of this line of rails will be understood at once from an inspection of a map; it forms a part of the main line which connects the northern provinces of France with Paris, and thus with the then investing German armies.

In order to effect only the most primitive connexion between the two banks of the Oise at the site of the destroyed bridge, all vessels and boats that could be obtained in any way, were collected, and by means of them a pontoon bridge was thrown over the Oise during the time from the 7th to the 17th of October (see dotted line in Fig. 4, page 119). The two inclined planes, by means of which this bridge had to be connected with the higher embankments, involved the construction of a line of rails of about one mile in length. The trains from Chantilly and Creil were brought close to the inclined planes, and the carriages were then drawn over the bridges on the left-hand bank of the river, by means of a portable engine, and on the right-hand bank by means of horses. Between the 17th of October to the 22nd of December, 2400 wagons or carriages were drawn in this manner over the bridge, and taking only two-thirds of that number as loaded, on the average, with about 100 centners, or, say, 5 tons, we get a total load transported of 8000 tons.

But simultaneously with the opening of the pontoon bridge, the construction of a fixed bridge had been commenced beyond the site of the former. The arches of the old bridge—an arched bridge with three openings, each of 92 ft. span—had been entirely destroyed, and although the abutment on the right-hand bank had remained solid up to the springing of the arches, the other abutment, as well as the two central piers, had been damaged in such a manner that it became impossible to repair them at that advanced time of the year, so as to use them for erecting a lattice bridge in place of the old bridge. It was, therefore, determined to construct a timber structure 104 metres (341 ft.) long, and consisting of 32 bays or pile works, at a distance of 3 metres (9 ft. 10 in.) from each other. (See Figs. 1, 2, 3, and 4, on page 119). The various piles as well as the several bays were connected with each other by the necessary longitudinal beams. For the passage of boats and vessels a wider opening of 29 ft. 6 in. span (Fig. 1) was left at the middle of the bridge; for this opening four longitudinal beams, each 2 ft. by 2 ft., and two others each 12 in. by 12 in. had to be obtained. All the beams were cut square out of oak, but the piles were made of round timber. The level of the rails on the bridge is 22 ft. above the level of the water, the depth of which is on the average about 10 ft., increasing, however, at high water to 16 ft. The height of bridge above mentioned necessitated a joint in the piles, and the height could, therefore, not be conveniently increased, although the considerable difference between the levels of the old and the new bridge involved the execution of much additional earthwork. These works—which could, however, be executed during the construction of the bridge—included important boring and blasting operations, for the cutting through the rock in front of the old bridge was 1640 ft. long, and 66 ft. deep. The cubic contents of the rock that had to be blown up or excavated for the new bridge amounted to 120,000 cubic feet. In order to connect the new bridge with the existing line of rails also, embankments had to be thrown up on both sides of the river, one of these embankments being 1200 ft. long.

Notwithstanding the many and great difficulties and obstacles which had to be overcome, and notwithstanding the circumstances that the smallest piece of wood as well as the heaviest timber beam had to be first cut in the forest, and often brought from a great distance by insufficient means of transport, and that for all these operations only French labourers were available, the construction of this bridge, which, even under ordinary circumstances would have been a work of considerable importance, was completed between the 15th of October and the 22nd of December.

Besides these works on the river Oise, the corps under engineer Glaser built at the Gonesse station three large goods sheds, which had to be connected by new lines and turntables with the existing line of rails. The goods from 1000 wagons could be stored in these sheds, and 100 wagons could be loaded in them at the same time. In order that these sheds might be used during the night, they had to be lighted with gas, for which purpose the existing gasworks had to be extended, and two new retorts had to be substituted for the old and worn-out one. Besides these sheds, a new platform, 400 ft. long, had to be erected for the unloading of heavy guns and ammunition, and new sidings had to be led off from the main line. Finally, we must say a few words about the operations of the Bavarian railway corps, which, with the co-operation of railway engineers from Baden, constructed—soon after the declaration of war, and in the short time of two weeks—the line from Bruchsal to Germersheim, by means of which a direct communication with the Rhenish railway was opened. After laying down a second line of rails from Weissenbourg to Hagenau, and from Winden to Wendenheim, and after repairing the lines and stations at Chateau-Thierry, Nogent, and Nanteuil, the Bavarian corps started in the beginning of October for Condé St. Librairie, near Meaux, in order to repair a bridge over the Marne, two arches of which, of a total width of 80 ft. and a height of 30 ft., had been blown up. When this work had been completed, a party of the corps had to be sent on October the 10th to the Paris and Orleans Railway, in order to restore the traffic on that line in the rear of the then advancing first Bavarian army. A distance of more than 60 miles was examined from the 11th to the 15th of October, during which time many rails and joints had to be relaid and fastened, and many culverts for the discharge of the accumulated water had to be repaired and cleaned. Another party of the corps had to work the line between Versailles and Chartres, but the largest portion of the men (about 140) had to undertake in the beginning of December, under the most trying and dangerous circumstances, the reconstruction of the destroyed bridge over the Seine at Montereau, near Melun.

The execution of these numerous works in the proportionately short time of scarcely four months, thus affording a means by which the military operations were successfully supported and accelerated, is a convincing proof of the importance of the railway department in modern warfare, and the railway corps attached to the German armies during the late war may be well content with their share in the ever memorable campaign in which they took part.

* Of the old bridge there remained, however, the piles, *a*, *a* (Fig. 6), which projected above the level of the water, and to which were secured the piles of the new structure.

TENDERS IN VICTORIA.—The Victorian Commissioner of Public Works has accepted tenders as follows: For the supply of about 650 tons of cast-iron water-pipes, Messrs. Bright Brothers and Co., 7*l.* 14*s.* 6*d.* per ton; taking up and reconstructing the outer division with the battery thereon of the railway breakwater pier, Williamstown, the Government to provide the piles and any sawn timber required, Messrs. Felt and Lillington, 2207*l.*

THE BRITISH ASSOCIATION.

REPORT OF THE COMMITTEE ON TREATMENT AND UTILISATION OF SEWAGE.

THIS Committee was first appointed at the Norwich meeting of the British Association in 1868, then reappointed at Exeter in 1869, and again at Liverpool in 1870. The report was submitted, as in former years, to Sections B and G, chemical and mechanical science, from both of which the Committee emanated.

Mr. R. B. Grantham, C.E., chairman of the Committee, reported as follows: Upon its reappointment at Liverpool last September, the Committee proceeded at once to consider the subjects which seemed to demand immediate attention in furtherance of the investigations which had been intrusted to it. The first steps taken were to endeavour to procure information from the towns where works have been constructed for the application of sewage to land by irrigation, and from the places where the dry earth, or Moule's system, was in operation. In order to commence the inquiry, a list of towns was prepared, to which a printed form of queries was sent, but only eight places had answered the circular on irrigation, and only one that related to the dry earth process. During the construction of the present tanks at Breton's sewage farm, near Romford, in the winter, very accurate observations could not be made; but, nevertheless, during the extreme frost samples were taken of the sewage and of the effluent water. The temperature of both, and also the atmosphere, were observed. Similar observations were made at Croydon and at Norwood. The observations as to the quantity and quality of the sewage and effluent water had been taken at Breton's farm, with slight interruptions, as stated above, from the meeting of the British Association at Liverpool down to the present time. The times of sowing and planting the several crops had also been recorded. The Committee had visited several sewage farms, and examined the various methods that were pursued at them, with a view to determining the practical conditions upon which the success of sewage farming depended. They had had samples of sewage and of effluent water collected, and had had analyses made of them. The phosphate process of Messrs Forbes and Price had been also examined by a member of the Committee. Analyses of the soil which had passed once and twice through earth closets had been furnished by another member. An ox which had been fed for the previous twenty-two months entirely on sewage-grown produce was slaughtered on July 15 at Breton's farm, and the carcase examined by Dr. Cobbold and Professors Marshall and Corfield, in the presence of several members of the Committee, with a view to ascertain the presence or absence of entozoa in any stage of their existence. The slime collected from carriers at the Earlswood sewage farm had also been examined microscopically, and reported upon by Mr. M. C. Cooke.

Mr. Hope gave in a detailed report on the experiments made at Breton's farm. He stated that in the 373 days from June 12, 1870, to July 15, 1871, the amount of town sewage received was 85,999,445 gallons, giving a daily average of 230,562 gallons. The effluent water discharged upon the farm in the same period amounted to 39,449,178 gallons, giving an average of 115,012 gallons. The diluted sewage pumped upon the farm was 96,944,653 gallons, giving an average of 264,876. The temperature of the sewage and effluent water was found to be very uniform as compared with that of the air, being lower during extreme heat and higher during extreme cold. This was very noticeable during the severe frost of last winter. The report was accompanied by a detailed account of the analyses which Dr. Russell of the chemical laboratory, St. Mary's Hospital, London, had made of various samples of the sewage supplied to Breton's farm, and the effluent water drained from it, together with samples of the sewage supplied to the Croydon and Norwood sewage farms.

There was next read a report on the sewage of farms at Tunbridge. Four points, it was stated, required to be noticed in connexion with the sewage from Tunbridge Wells: firstly, in the selection of the land to be irrigated it had been made a *sine quâ non* condition that it should be such a level that the sewage should reach it by gravitation, and to this end two farms had been laid out, one to the north and the other to the south of the town, and an outfall sewer made to each; secondly, the total absence of underground drainage from a large portion of the land, and the adoption of peculiar arragements where underground drainage previously existed; thirdly, the distribution of the sewage by what is known as the catch-water system, which is necessarily accompanied by an overflow in preference to its distribution in smaller quantities sufficient to satisfy the demand of vegetation, and to wet the land thoroughly without any overflow; and, fourthly, the absence of storage reservoirs which necessitates the continuous application of the sewage to some parts of the land by night as well as by day. The soil of nearly the whole of the northern farm consisting of 123 acres of land, was of a clayey character, manifestly requiring an underdrainage. The land of the southern farm, extending to 167 acres, was not generally of quite as heavy a description as that of the northern, though parts of it contained much clay. Some parts were peaty, and naturally very poor. The results of the operations that had been carried out elicited the necessity of combining with the services of the chemist and engineer that of the agriculturist. The striking features in these cases were, first, that, instead of concentrating the sewage at one farm under one management, it had been divided into two parts; second, that the main conduits and carriers had been expensively constructed; third, the character of the under drainage necessarily prevented the deep working of the soil, and was unfavourable to the complete and uniform aëration of the subsoil, which insures the oxidation of the organic matters contained in the sewage; and fourth, the distribution of the sewage was unequal both in quantity and quality.

Dr Corfield gave in a report in reference to the sewage and effluent water used on the Tunbridge farms. In regard to the northern farm, he stated that it appeared that the

sewage from the main, while containing a comparatively small amount of solid matter in solution, contained a very large proportion of "actual" ammonia, and also of albuminoid ammonia, when both the suspended and the dissolved matters were taken into account. It was a rich sewage, whether the proportion of nitrogenous matters to the total solids or to the bulk of the sewage itself was considered. The almost total absence of nitrates and nitrites in the effluent water showed the want of conditions favourable to continuous oxidation, so that the purification of the sewage on this farm, although considerable, was not so satisfactory as could be wished, or as might be effected by making filtration through the soil an essential feature in the process. The results arrived at at the southern farm were very unsatisfactory, but at the same time very reliable. The analyses showed distinctly that as these two farms were at present managed, more sewage was applied than could be purified by the surface flow, even when that takes place through thick vegetation, and much more than can be purified under less advantageous conditions. The temperature of the effluent water of the northern farm was only slightly below that of the sewage; while the effluent water of the southern farm was actually one-half degree (Fahr.) warmer than the sewage, which clearly showed that the sewage had not been subjected to the cooling which percolating through soil entailed.

Mr. Hope submitted a report on the sewage farm of Earlswood, designed for the utilisation of the sewage of Red Hill and Reigate. It stated that the sewage before being delivered to the land for irrigation passes through a Latham's patent extractor, an ingenious contrivance for separating the solid from the liquid portion of the sewage. The latter is delivered from the extractor by covered conduits by means of which it is directed right and left into the highest carrier by stops or sluices. The committee reported that it appeared to them that as the subsoil was kept in a saturated condition by the want of under drainage, certain atmospheric conditions must exist which might be attended by malarias more or less provocative of disease. On the 15th July, 1871, it was found that more leakage passed off the land at the outfall than there was sewage delivered to it.

A brief report, supplemented by analysis made by Dr. Russell, was submitted in reference to the sewage of Ely, which is passed upwards through filter beds of coarse and fine gravel and sand before it is discharged into the river Ouse. This process is found to reduce the amount of suspended matters from 47.5 parts, per 100,000 to 18.4 parts, and likewise to some extent the amount of solid matter in solution.

The next report read was on the phosphate process of Messrs. Forbes and Price, as described by Mr. David Forbes, F.R.S., at the Liverpool meeting of the British Association last year. This process, it was stated, was in operation at Tottenham. The sewage, after passing through some depositing tanks, which had been constructed for the lime process, was pumped up at the rate of 800 or 1000 gallons per minute along a carrier into a tank 100 yards long, and of gradually increasing breadth. This tank took three hours to fill. As the sewage passed along the carrier the chemicals were mixed with it thus: Two boxes were placed over the carrier, one a few yards further along it than the other; the first contained the phosphate mixture, and the second milk of lime; men were continually stirring the contents of each box, which were allowed to run continuously into the sewage as it passed beneath the boxes. The amount of the preparation added was not ascertained, but it was stated to be certainly much less than the proportion indicated by previous experiments (1 ton to 500,000 gallons of sewage). The result of this preparation was to deodorise the sewage to a very considerable extent indeed, and when some of it was placed in a precipitating glass, and allowed to stand, a speedy separation of the suspended matters took place. The milk of lime was added to precipitate the excess of phosphate added, and just sufficient milk of lime was allowed to flow in to neutralise the sewage, the reaction of which to test paper was ascertained from time to time after the addition of the milk of lime. During the passage of the sewage thus treated through the large tank, the suspended matters were very completely deposited, and the supernatant body ran over the sloping edge of the tank at its extreme end, bright and clear, and almost odourless. Some of this water was collected, and was kept sealed up in a stone jar until July 24, when it was analysed by Dr. Russell. It was found, after the interval of four months, quite sweet, and without smell. The suspended matter was in very small quantity, and consisted merely of a little whitish flocculent matter, doubtless lime' due to the slight excess used on the day when the sample was collected. The water was quite clear, and only on looking through a considerable depth could a brownish tint be detected. The analysis of it showed that it contained as much "actual" ammonia as ordinary dilute London sewage, and also a certain amount of albumenoid ammonia. It contained the merest trace of phosphoric acid, as indicated by the molybdate of ammonia test, and no sulphuretted hydrogen nor any nitrates or nitrites. Some of the deposit had been taken out of the tank, and was drying in a shed, the water which separated from it forming little pools on the surface of the mass. Both this water and the precipitate itself were free from all offensive smell. It appeared, then, that the suspended matters were entirely removed by this process, but the "actual" ammonia, and, to a certain extent, the soluble organic matters, were entirely removed from the sewage when oxidised; but an odourless precipitate was produced which contained all the phosphate added, and contained it, doubtless, in the form of flocculent phosphate of alumina, the value of which as a manure was somewhat doubtful, being certainly not as great as the value of corresponding quantities of flocculent phosphate of lime. The valuable constituents of sewage, with the exception of the suspended matter and the phosphoric acid, were not precipitated by this process, and could not be utilised unless the effluent water were afterwards used for irrigation, in which case the milk of lime would not be added, and the clarified sewage would still contain a quantity of phosphoric acid. The advantages of its use, if it were found to answer, from an economical point of view, would be the deodorisation of the deposit in the tanks and of the sewage itself, which was certainly at present a great desideratum, especially as regarded the tanks.

Dr. J. H. Gilbert, F.R.S., reported the results obtained on the use of Moule's earth closet, stating that 14 cwt. of air-dried and sifted clayey soil had been used in the experiment. The increase in the percentage of nitrogen was only about 0.15 each time the soil was used; and even after being used twice the soil was not richer than good garden mould. It was obvious, therefore, that such a manure, even if disposed of free of charge, would bear carriage to a very short distance only.

The concluding reports were the one by Mr. M. C. Cooke giving the results of a microscopic examination of the slime and mud collected from the bottom and sides of the sewage carriers at Earlswood Farm, and the one by Dr. Spencer Cobbold, F.R.S., in which he gave a detailed statement of a minute examination which he had made upon the organs and tissues of an ox fed for two years upon sewage-grown grass. He said that the animal was perfectly free from internal parasites of any kind, and he proceeded to attempt to account for this most unexpected result.

A good deal of discussion was provoked by the various reports, and regret was expressed that the members of the committee were not at liberty to spend the funds at their disposal in defraying their travelling expenses when they required to go from home on the business of the committee.

At the last meeting of the General Committee of the Association the sewage committee was reappointed.

INDIAN ENGINEERING EXAMINATION.

TO THE EDITOR OF ENGINEERING.

SIR,—Will you kindly allow me to draw attention to a few facts connected with the late examination for direct appointments in the Indian P.W.D., which do not, to say the least of it, reflect much credit on those who conducted the proceedings.

To commence at the beginning, I sent in my certificates, &c., in July, and a few days afterwards received a note informing me that my number was 194. The others were numbered in the same way, the highest being over 300, the true number of candidates being 51. Doubtless the India Office people have a perfect right to number candidates in any way they think proper, but as in every other competitive examination the numbers always run consecutively, I should like to know why it was not done on this occasion, unless it was meant to discourage those living at a distance from going up.

As regards the medical examination, in addition to those two cases mentioned by "One of the Sufferers" in your last issue, I can name a few other suspicious cases.

Case No. 1. Had been up on three previous occasions, and had been pronounced fit by the Board on each occasion, but was rejected this time on account of varicose veins.

Case No. 2. Had been up on one previous occasion, and had been passed by the Board, but rejected this time on account of varicose veins.

Case No. 3. Had been up on one previous occasion and pronounced fit by the Board, but rejected this time on account of irregular action of the heart, he had also been examined by a medical man about six weeks before, who said he was perfectly sound.

Of course, Sir, you can draw your own conclusions, but does it not seem strange that so many became "constitutionally unfit" in the same year?

I cannot agree with you that "with regard to the large number rejected by the Medical Board it only tends to prove that those candidates who were rejected had not taken the ordinary precaution beforehand of ascertaining whether or not they had any physical affection which would be likely to render them unfit for service in India." I myself (and several others that I know) had taken the precaution of being examined by a medical man, but he could discover no physical affection. I have since consulted several other members of the faculty, but have not found any one who agrees in the opinion of the Indian Medical Board. Thinking some mistake had occurred, I applied to the India Office to be re-examined, but was refused.

The result of the remaining part of the examination is truly astonishing. It is difficult to say on what principle the marks were awarded.

I personally know nearly half the candidates, and all I can say is, that had the examination been conducted in the usual manner, the result would have been very different.

I should like to know why the examiners were changed this time, and, above all, why were men from Coopers Hill College appointed to examine?

The greater number of the candidates who presented themselves this time, had been engaged on actual work, beyond the prescribed minimum time (3 years), many from 5 to 7 years, and some had had the superintendence of important works, yet there was a complaint made by the engineering examiner that they had shown a deficiency in practical knowledge. Does the Indian Government expect to get more practical men from the new college, where they are only to get one year of practical work, and probably not that, as no civil engineer in good practice would care to take them for so short a time?

I have no doubt but that the new college will be pronounced a great success, as, even if a failure as far as educating young engineers is concerned, it will still be a convenient home for retired Royal Engineers.

Yours obediently,

August 21, 1871. T. W. DAVIES.

STEAM NAVIGATION IN THE BOSPHORUS.—Another new steamer (No. 28) for the Bosphorus service of the Shirket-i-Hairié Company has arrived out from England.

BLAST FURNACE CINDER.

TO THE EDITOR OF ENGINEERING.

SIR,—Some time ago I remember reading an account either in your own or some other journal, of a method of disposing of blast furnace cinder which seemed to me so good that I determined if I should have an opportunity of adopting it to make very full inquiries. According to this plan the liquid cinder ran into a funnel-shaped receiver where it met with water, and was, I think, carried forward by some mechanical means in the water into a tank where it settled upon the bottom in a disintegrated state. From this tank it was loaded into trucks for ballast, building, &c., by means of a Jacob's ladder chain. I fancy the plan was in use at a set of furnaces in France, and I know it said they had continued it long enough to have filled a quantity of land up with the disintegrated cinder which had set in hard that they had built manufacturing works on it without foundation.

I shall be very glad if you or some of your readers can give me some further particulars concerning this method of disposing of blast furnace cinder and can inform me where it is in use.

I am, Sir, yours obediently,

August 18, 1870. IRONMASTER.

[We shall be glad to receive particulars of the plans referred to by our correspondent.—ED. E.]

TITANIUM AND IRON.

TO THE EDITOR OF ENGINEERING.

SIR,—Referring to the correspondence in your issues of late on the above subject, more particularly to the letter signed "Hematite," and the reply by your correspondent "E. T." in ENGINEERING of the 11th inst., I beg to say that "Hematite" is quite correct in stating that titanium was found in the hearths of the Cleator Moor furnaces some years previous to Irish ores being used in Cumberland. "E. T." says "I can quite realise that a furnace will collect a few pounds of titanium when it smelts 200 tons of ironstone per day for ten or twelve years." The few pounds alluded to by "Hematite" was a small portion of many cwts. got from a furnace smelting about 200 tons of ore per *week* instead of per day, and for two years in place of ten or twelve. This was no exceptional case, as titanium in large masses was invariably found in the hearth of each furnace when blown out for repairs and this occurred each 2 to 2½ years per furnace.

I am, Sir, yours respectfully,

ISAAC ARMSTRONG,

Manager at Cleator Moor at the period referred to by "Hematite."

Maryport, August 19, 1871.

IRON RAILWAY SLEEPERS.

TO THE EDITOR OF ENGINEERING.

SIR,—In the 4th of August number of ENGINEERING, in describing the visit of the Mechanical Engineers to Messrs. Thomas Richardson and Sons of Hartlepool, you say: "At the time of our visit the foundries were principally employed on sleepers, of Mr. Livesey's pattern, for tramways at Buenos Ayres, and excellent sleepers they are. One we saw tested stood, before cracking, eight blows from a tup weighing 8¾ cwt., and falling 10 ft., this tup striking on a bar placed on the sleeper in the place which would be occupied by the rail, and resting on the pieces of wood lying in recesses in the sleeper, and the latter being itself bedded in loam. The resistance offered by this particular sleeper was certainly somewhat exceptional, but it was a common thing for the sleepers to resist three or four such blows before fracture." I cannot imagine how this mistake has occurred, but I beg to inform you that the engineers assembled did not see one of Mr. Livesey's sleepers tested, if they had done so, they would have had to report a very different result. The sleepers they saw tested were my patent improved sleepers now in course of manufacture for the Bahia and San Francisco Railway, and it is a fact that can be easily proved, that Messrs. Livesey and Edwards's patent sleeper will not stand the test of the same weight falling 5 ft. The result was equally unsatisfactory when the engineers for whom they are made had some of them sent up to the testing machine at Lambeth. I should remark that these sleepers are 10 lb. heavier than mine, they being 70 lb. each, and the others 80 lb. I am not at all surprised at this result, as this was the first form of sleeper I employed twenty years since on the Lancashire and Yorkshire Railway, and on the then Eastern Counties, but the result soon taught me that it was a very bad arrangement of metal, as in cooling the contraction is so unequal that one part of the sleeper throws a strain on all the other part, and, consequently, very slight concussion breaks it. In fact, a better illustration could not be given to the experienced, than in the fact that the first sleepers of this pattern, that were attempted to be made to the order of Messrs. Livesey and Edwards, fifty were cast before one would stand the contraction in cooling.

I am, Sir, yours truly,

H. GREAVES.

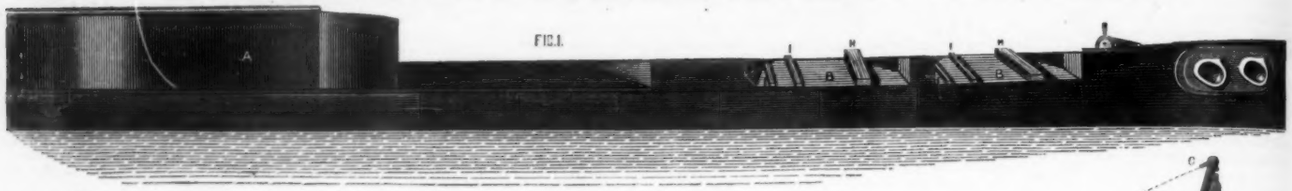
18, Abingdon-street, Westminster.

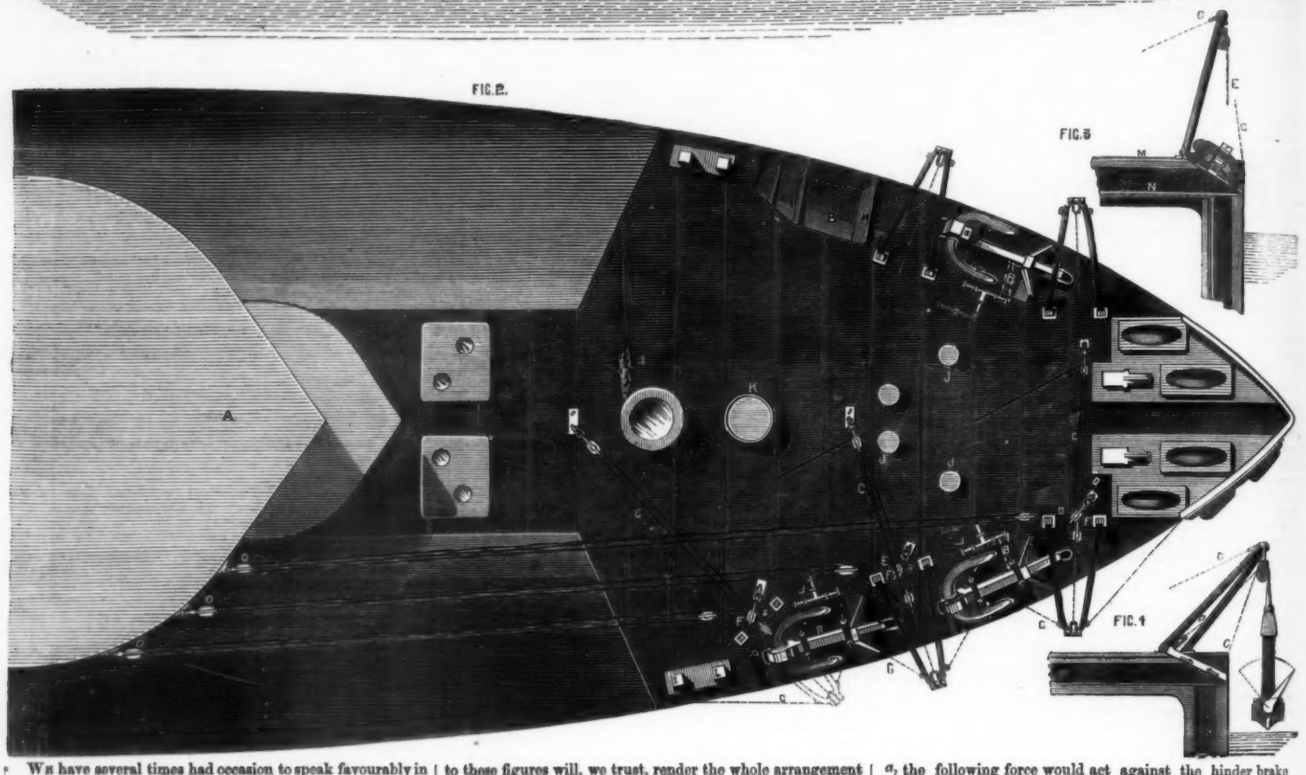
[Mr. Greaves is perfectly correct in stating that the sleepers of which the tests were witnessed by the members of the Institution of Mechanical Engineers who visited Messrs. Richardson's works were his and not Mr. Livesey's. We regret the error which inadvertently occurred in our article. —ED. E.]

DEFENCES OF ADEN.—The scarping of the range of hills to the south of Camp overlooking Fisherman's Bay, has been completed at a total cost of 21,504 rupees; the Napier battery, on the southern range, would have been completed had the racers been received. The batteries at Ras Morbut and Ras Tarshayne have been altered to suit them for heavy ordnance. An open battery has been commenced on Seerah Hill, and improvements have been made in the Seera Mole Fort.

FORE PART OF H.M.S. "GLATTON."

SHOWING ARRANGEMENTS FOR CATTING, FISHING, AND STOWING MARTIN'S ANCHORS.





We have several times had occasion to speak favourably in this journal of the performances of Mr. Martin's self-canting anchor, and about sixteen months ago (*vide* page 268 of our ninth volume), we illustrated and described Mr. Martin's latest pattern as now being adopted largely in our own and several foreign navies. This account of the anchor itself we now supplement by giving engravings illustrating the arrangements adopted for catting, fishing, and stowing these anchors, as applied to H.M.S. Glatton. These arrangements, which have been designed by Mr. Martin, have not only been adopted in the Glatton, but are also being carried out in the Devastation, the Thunderer, the Gorgon, the Cyclops, the Hecate, and the Hydra.

In the case of an ironclad which is intended to be used as a ram, it is of great importance that the anchors should be so stowed that they are not likely to be displaced by the shock of ramming, and that all projections from the sides of the bow should, as far as possible, be avoided so as to prevent chances of fouling. The arrangement devised by Mr. Martin fulfils both these conditions perfectly. Instead of employing catheads or other equivalent projections from which anchors could be let drop clear of the ship's side, he simply places his anchors in inclined recesses, as shown in the plan and the section, Fig. 3. The peculiar form of his anchors enables them to lay perfectly flat on the inclined guides with which the recesses are provided, and when let go they, as it were, launch themselves off these guides, and are delivered quite clear of the sides of the vessel. At the same time it will be seen that the anchors when stowed, are kept completely within the line of the ship's side, and are so held as not to be in any way liable to displacement by the shock of ramming. To enable the anchors to be released rapidly, the ends of the two chains, by which each anchor is held in place, are hooked on to studs projecting from a bar which is capable of revolving in bearings fixed to the deck, as shown in the plan. This bar is then turned so that the studs hold the chain securely, and it is locked in that position by a sliding socket, which embraces another stud upon it, as shown. By simply withdrawing this socket by means of a lever provided for the purpose, the bar is left free to revolve, the two chains are thus simultaneously unhooked, and the anchor is launched fairly down its guides. The shear legs by the aid of which the anchors are catted and stowed fold back flat on the deck when not in use.

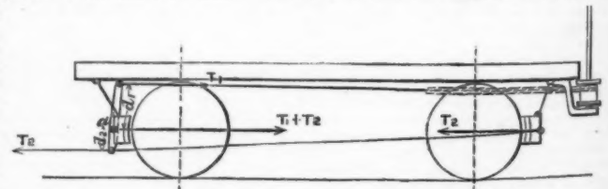
In our engravings, Fig. 1 is an elevation of the forecastle of the Glatton, showing the recesses for stowing the anchors; Fig. 2 is a corresponding plan; Fig. 3 is a section showing one of the anchors fished and stowed; and Fig. 4 is a section showing one of the anchors catted. The following references to these figures will, we trust, render the whole arrangement perfectly clear to our readers.

A. Breastwork.
B. Recesses for stowing anchors.
C. Topping lift.
D. Cat pennant.
E. Fish pennant.
F F. Portable iron snatch-blocks.
G G. Chain guys.
H H. Wooden chocks under the stocks of anchors to stow the shanks level.
I I. Iron guides for launching anchors.
J J. Rising bitts.
K. Capstan.
L L. Stoppers for releasing anchors.
M. Forecastle.
N. Upper deck.
O O. Treble blocks.

RAILWAY BRAKES.

To the Editor of Engineering.

Sir,—In your paper of the 7th ult., in describing the brake of the goods' wagon for the Villa Maria and Rio Cuarto Railway, you remark that "the brakes are applied with uniform force to the four wheels simultaneously." As a regular reader of your excellent paper, and in the interest of those of your readers who, like myself, may be studying the important question of how to obtain a simple and efficient brake for railway stock, I beg leave to correct what appears to me to be an error in the above quoted statement, and to show that the blocks on the wheels which we will call the hinder, furthest from the vertical brake shaft, are pressed against the wheels with more force than are the blocks of the other or fore pair of wheels.



Let T, on the annexed sketch, represent the force transmitted by the drum on vertical brake spindle to the top of the lever, this force is applied at the distance, d_1, from the fulcrum, a, of the lever, which point is also that of its connexion with the hinder pair of blocks. The short end of the lever, whose length is d_2, would transmit to the blocks on the fore pair of wheels the force $T_2=\frac{d_1}{d}$, and at the fulcrum, a, the following force would act against the hinder brake blocks, $T_1+T_2=T_1\left(1+\frac{d_1}{d_2}\right)$.

Therefore the hind brake blocks are pressed with a force greater than that applied to the fore blocks by the value of T_1. Under these circumstances, supposing the weight of the wagon to be uniformly distributed on the four wheels, what will occur is this: the hind pair of wheels will be stopped whilst the other pair of wheels will continue to turn; the blocks on the hinder wheels will wear out sooner than those on the other wheels. Thus the brake on the wagon of the Argentine Republic must be considered as an imperfect one, not using the whole of the available weight for stopping the train, and, by unequal wear of blocks and wheels, unnecessarily leads to increased expense of maintaining the rolling stock, as a result of skidding the tyres.

I am, Sir, yours most obediently,
A Russian M.E.

St. Petersburg, August 3-15, 1871.

[Our correspondent is perfectly correct in his assertion that in the wagons to which he refers the pressure upon the brake blocks is unequal. The inequality could, however, be readily arrested by attaching the blocks for the "front" wheels to hangers alung from fixed points in the frame, and extending the hangers downward, so that the links by which the strain is transmitted to the blocks could be attached to the hangers at a point below the centre of pressure of the blocks on the wheels. To produce equality of pressure the distance from point of suspension of hanger to point of attachment of link should bear the same proportion to the distance between the point of suspension of the hanger and the centre of pressure of the block on the wheel that d_1+d_2 does to d_1.—Ed. E.]

RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 2350, 1s. 2d.) Thomas Lacy, of St. Paul's-road, Canonbury, and Stephen Charles Lacy, of Canonbury-park-square, patent arrangements for automatically stopping the flow of gas through a gas meter when any particular quantity, previously determined upon, has been supplied. We could not describe the details of this apparatus briefly.

(No. 2353, 10d.) Herbert John Haddan, of 67, Strand, patents, as the agent of William Sykes, of Toronto, a method of constructing subaqueous tunnels. Mr. Sykes proposes to form such tunnels by first dredging a trench along the line of the work and then sinking in this trench a shield consisting of a bottomless structure of ∩-section made in convenient lengths and connected at its ends to barrels rising above the water line. It is proposed that each length of this shield should be floated into position by the aid of pontoons and then sunk so that its edges, which may be strengthened by cross grids, may cut into the substratum and form a watertight joint; the water is then to be pumped out and the work carried on within the shield, the turrets being used for the introduction of materials. The spaces between the adjacent ends of the lengths of shield are to be closed by caissons, or piling, and on the work being completed the turrets are to be removed leaving the main body of the shield as part of the permanent structure. We fear much difficulty would be experienced in carrying out these plans in practice.

(No. 2367, 8d.) Matthew Gray, of Highbury-hill, and Frederick Hawkins, of Silvertown, patent protecting the external wires or armour of telegraph cables by lapping round these wires, previous to their being applied to the cable, strips of woven cloth saturated with some approved waterproof composition.

(No. 2368, 4s.) William Edward Newton, of 66, Chancery-lane, patents, as the agent of Richard March Hoe, New York, improvements in lithographic printing machines, and in apparatus for grinding or preparing the surfaces of stones used for lithographic purposes. The details included in this specification are far too numerous for us to attempt to describe them here.

(No. 2369, 4d.) Andrew Noble, of Newcastle-upon-Tyne, patents arrangements for firing torpedoes, of that class in which the explosion is caused by the completion of an electric circuit on a torpedo being struck by a passing vessel. At present it is usual where such torpedoes are used to employ a separate circuit to connect each torpedo with the firing battery, and the object of Mr. Noble's plans is to dispense with this multiplicity of circuits and enable one circuit to be used for a whole series of torpedoes. This object is attained by connecting the torpedoes to the insulated conducting wire in such a manner that the explosion of any one of the series at once severs the communication of that torpedo from the circuit without interfering with the electrical communication between the other unexploded torpedoes.

(No. 2373, 1s.) John James Bodmer, of Newport, patents apparatus to be employed in carrying out his mode of manufacturing iron and steel, the present patent including the use for the purpose of puddling, of one or more hollow drums revolving within a furnace on horizontal axes, the peripheries of these drums being covered with fettling material. Particular methods of applying the fettling to such drums as well as the use of rolls within a furnace for squeezing the cinder out of the charge, appliances for withdrawing the blooms from the furnace, and a method of preparing oxide of iron by a continuous process, are also included in the patent.

(No. 2380, 8d.) William Rudd Oswald, of Pallion High-yard, near Sunderland, and William Kenmire Swaddle, of New Hendon, near Sunderland, patent so constructing engines that the water arising from the condensation of the steam in a surface condenser may be injected amongst the exhaust steam on the way to the condenser previous to being forced into the boiler. The object of these plans, which are neatly worked out, is to obtain feed water at a higher temperature than that which it possesses when drawn from the condenser in the ordinary way, but we fear that any extra heat imparted to it by the exhaust steam when injected amongst the latter will be almost immediately lost by evaporation as the vacuum forms in the condenser. Several schemes for obtaining the same end have been proposed before.

(No. 2387, 2s. 6d.) Wordsworth Donisthorpe, of Belvedere, Harrogate, and William Leatham and George Edmund Donisthorpe, of Leeds, patent arrangements of coal-cutting machinery, which we cannot describe in detail here. We may mention, however, that the plans include arrangements for giving to the pick a compound curved course, while, in other cases, the pick is driven by the action of spiral grooves formed in the exterior of a plunger which is caused to reciprocate in a direction at right angles to the plane of rotation of the pick.

(No. 2393, 8d.) Constantine Henderson, of 8, Grace-church-street, patents constructing girders by turning arches of brickwork between skewbacks connected by a wrought or cast-iron tie.

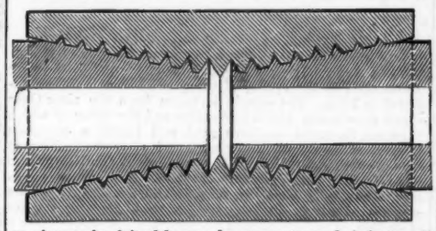
(No. 2397, 8d.) George Haseltine, of Southampton-buildings, patents, as the agent of Samuel Danks, of Cincinnati, U.S., a form of rotary puddling furnace which has lately attracted much attention on the other side of the Atlantic We describe this furnace on page 130 of the present number.

(No. 2404, 8d.) Stephen Meredith, of Burnt Tree, Tipton, patents methods of constructing puddling and balling furnaces, the leading features in these plans being that the sides and bottoms of the furnaces are made so that they can be kept cool by water, while the beds of the furnaces are made of an elliptical form in plan with a view of economising the fettling with which the bottom and side plates are covered.

(No. 2414, 10d.) William Edward Newton, of 66, Chancery-lane, patents, as the agent of John Benjamin Root, of New York, modes of constructing water tube boilers. The boilers formed on these plans consist of a series of chambered heads composed of independent water "uptakes," these heads being connected by inclined water tubes which are connected to the heads by slip joints which allow of their ready removal.

(No. 2430, 10d.) James Eastwood, of Blackburn, patents forms of feed-water heaters. According to these plans a water jacket is placed round the flues by which the hot gases escape to the chimney, and the feed water is pumped through this jacket on its way to the boiler. We greatly doubt whether there is anything new in the arrangements proposed. The patent also includes a form of vacuum valve for steam boilers, and arrangements of scrapers for keeping the flues through the water heaters clear of soot, &c.

(No. 2433, 8d.) John Henry Johnson, of 47, Lincoln's-inn-fields, patents, as the agent of William Clare Allison, of Philadelphia, U.S., a method of joining pipes, rods, &c., by a screw coupling having internal tapering and vanishing screw threads as shown in the annexed sketch. The rods



or pipes to be joined have, of course, tapered ends to suit the coupling. The arrangement appears to be a good one, tending to prevent the weakening of the rods or pipes at the joints.

(No. 2436, 1s. 2d.) Loftus Perkins, of Seaford-street, patents an arrangement of locking gear for the fore carriages of road vehicles, the leading feature in this arrangement being that the freedom of the fore axle to rock is gradually diminished as the fore carriage locks round.

THE STOWMARKET EXPLOSION.

WE, last week, referred in general terms to the recent explosion of gun-cotton at Stowmarket from which a fearful sacrifice of life and property has resulted. The inquiry into the circumstances attending the explosion was resumed on Friday last, upon which occasion evidence was first given to establish the identity of such of the deceased parties as had been found or could be recognised. The coroner, Mr. F. B. Marriott, stated that he had communicated with the Home Secretary, in consequence of which Captain Majendie had been sent down to the scene of the disaster. Captain Majendie had recommended that samples of the gun-cotton remaining at the works should be sent up to two eminent chemists to be analysed on the part of the Crown. The Home Secretary had authorised this course, and the results of the analyses will be made public. The first witness examined upon points connected with the explosion was John Thomas, one of the workmen at the factory. He stated that he had no fault to find with the manner in which the gun-cotton was manufactured, although he had sometimes observed it to smell strongly of acid. He thought the magazines were hardly safe, and were likely to be affected by heat, although he could not say at what temperature gun-cotton would be liable to explode.

Mr. Saunders Trotman, the manager of the works, was next called, and he described the part he took immediately after the explosion—he being in his office when it occurred—in rescuing several of the sufferers from the ruins, although himself much injured. He then gave evidence upon the question of the manufacture and storage of the gun-cotton, from which it appears that all the materials used at the works are tested at a laboratory in the town of Stowmarket, by Mr. Slater, the analytical chemist to the company. The average weekly production of gun-cotton at the works was about 5 tons, and there were about 15 tons in the three magazines when they exploded, about 10 tons having been sent away a few days previously to the accident. The gun-cotton manufactured at Stowmarket was of two strengths, that possessing the superior dynamic force being for supply to the Government, and that having the inferior being used for mining purposes. Samples of the gun-cotton made were sent to the laboratory in the town to ascertain that it was up to the required standard. The fuses used in firing the gun-cotton are not inserted in the gun-cotton stored in the magazine, and in fact the company have nothing to do with the fuses, and none are kept on the premises.

As regards the process of manufacture, Mr. Trotman stated that the cotton—which was prepared cotton waste obtained from Manchester—was first cleaned, and then sent to be dipped in the dipping-houses. After having been cooled for 24 hours, the cotton was centrifugued to expel the superfluous acid. It was then tubbed or washed, again centrifugued, and laid in tanks of water to soak. When wanted it was carried to be beaten or broken into pulp. Having been so beaten, it was let down into the poachers for washing. The quantity of acid allowed was 18 lb. to each pound of cotton. The quantity of acid used would not affect the storage of the cotton, but would affect its solubility. The second quality of cotton made at the works, which was manufactured for mining purposes, was quite as pure as that made for the Government, as it was not known in the early stages what its destination would be. There was an explosion at the works three years since. At that time the drying was all conducted in one house, into which hot air was admitted. The explosion seemed to have arisen from some alterations which were going on, which caused the ventilation to be defective, and the temperature to be too high. No explosion had ever happened at the factory which could not be accounted for. No thermometer was kept in the magazines. The cooling pits were somewhat affected by the weather. The cotton which exploded and which killed the Messrs. Prentice was packed in Government cases. The cotton varied somewhat in its manufacture and packing according to the views of different Governments and clients. The highest quality of gun-cotton was the most stable, and consequently the least dangerous. To make gun-cotton by the regular process would take, under favourable circumstances, from seven to eight days. There were nine poachers at the works, and each would hold about 1000 lb. of cotton; they were always kept at work. Mr. Trotman stated that he had no theory on the subject of the explosion, except that the sun's heat had caused it. August was an unlucky month for gun-cotton.

Upon his cross-examination Mr. Trotman stated that the works were designed by him, but that after the recent explosion he should not select the same site again. Strong brick walls and buttresses had been substituted for the mounds originally formed for the protection of the magazines; they were considered a better protection than the mounds, hence the alteration. The mounds were also found to slip, and hence another reason for their substitution by brick walls. Mr. Trotman stated he had never received any complaints or warnings from any one as to the condition of the works. In answer to Captain Majendie, he further stated that he had no doubt the explosion occurred in the magazines, and that it was due to solar heat. An explosion had occurred before at the works, when a case was being packed with compressed gun-cotton, and a man and two girls were then much burnt. Occasional ignitions had occurred at the works, but they were not attended with serious results. Prior to the close of the day's proceedings, Mr. Trotman was further examined, and said that, about a fortnight before the explosion, while some of the cotton was drying, he smelt nitrous fumes, which showed that there was too much acid left in the cotton. The fact of too much acid being left in the cotton would render it very liable to spontaneous combustion. No cotton was, however, removed from the magazines in consequence.

The proceedings were resumed on the following day, when the coroner stated that he required that samples of gun-cotton from the works should be analysed by two chemists. One of the gentlemen to whom he had applied, Professor Bloxam, declined to undertake the analysis, and he had heard nothing from Dr. Russell, who had also been applied to. Consequently, although he had the authority of the Secretary of State to employ two eminent chemists, he had not yet engaged any. Professor Abel said he wished to deny the statement that had appeared in some of the papers that he was a shareholder in the Gun-cotton Company. All the interest he had in the company was that, as owner of the patent which the company was working, he received a royalty, except upon all sales made to the Government. He was not connected with the management of the works, but when any question had arisen in which his opinion was likely to be of service, he had freely given it. He intended to tender himself as a witness.

Mr. Trotman made some additions to and amendments in the evidence he had given on the previous day, his statement having been made whilst suffering considerable pain. In the first place he wished to say in answer to a question put by Captain Majendie, that some cotton made by the old process had been removed from the magazine. Two years since some cotton was discovered which was bad, and charges were removed from the magazine in consequence. The second point was, that some months since a general clearance was made of cotton from the magazines, when new poachers were established; not the least sign of deterioration was then observed in the cotton. No cotton made by the new poacher process had ever been removed from the magazine except for alteration in its mechanical form. He thought, on reflection, that there must have been a larger quantity of cotton in the first magazine than he had stated. With regard to the cotton from which he had detected suspicious fumes about a fortnight since, it was impossible that it could pass muster without notice. There was no danger of the cotton passing muster as it were. Mr. Eustace Prentice took samples of the impure cotton in question to the laboratory in the town to be again tested. Some samples of the cotton were still in existence. Some of the impure cotton got into the drying-house near the magazine. He had still faith in his system of making gun-cotton. Every one must have been aware that there was something extraordinarily wrong in the impure cotton. There was no difference in the outward appearance of the impure cotton, but it gave out a very pungent, disagreeable smell. The ground of his confidence in the cotton stored in the magazine was, first, the chemical tests; secondly, cotton showing no departure from the chemical tests; thirdly, everything which was dried was placed upon the dryers and subjected to a temperature of from 170 to 200 degrees for a period of 24 to 36 hours, and if anything were wrong in the cotton it would be sure to display itself, as it did in this case. It was the Government cotton which showed the impurity. Mr. Trotman withdrew his opinion that the explosion was caused by solar influence,

and stated that he had no substantial theory on the subject. Ignitions of cotton on the dryers were not uncommon; the usual working temperature of the dryers was 200 degrees.

Colonel Younghusband, the superintendent at the Royal Gunpowder Works at Waltham Abbey, was next examined. He stated that he was president of a committee which had made a series of experiments with Abel's compressed gun cotton. The experiments had established the following points: 1. The non-liability of compressed gun-cotton to explosion by accidental ignition when stored in magazines in the proposed boxes. 2. The ignition of a package of compressed gun-cotton forming part of a store is not necessarily attended by the immediate ignition of neighbouring boxes, as would be the case with gunpowder. 3. Gun-cotton is perfectly non-inflammable when stored in a damp condition. The committee came to the unanimous conclusion that gun-cotton would not explode when merely ignited. It was a question whether on a magazine being exposed to fire for a considerable time an explosion would follow. Colonel Younghusband considered that the second explosion was caused by the handling of the boxes by Messrs. Prentice; if they had not gone to the packing shed the second explosion would possibly not have happened. He thought it improbable that the explosion was caused by the simple ignition of the gun cotton. He had no theory as to the first explosion; he thought, however, that gun-cotton in the magazines was so nearly the exploding point that the explosion of a part determined the explosion of the whole. It was highly desirable that further experiments should take place before the storage of gun-cotton in a dry state on a large scale, although he did not think it necessary that there should be further experiments before the manufacture of gun-cotton on Abel's patent was continued. In consequence of the explosion the store of Government gun-cotton at Upnor Castle had been examined and soaked in water; it was now in a perfectly safe state. Witness thought that large quantities of gun-cotton could not be safely stored in a dry state; at any rate, he considered that further experiments were necessary. He had had no experience as to the effect of solar heat on gun-cotton; he did not think, however, it would be heated up to the explosive point.

The next witness examined was Mr. J. W. Slater, the analytical chemist to the company, and whose evidence we subjoin *in extenso*. He stated that he had to test or superintend the testing of all the samples sent up from the poachers. The first test was the solubility test, to determine the relative strength of the samples. Twenty grains of the samples (which were dried after they came up from the works, and exposed for an hour to common temperatures) were placed in a wide glass tube closed at one end, and three fluid ounces were poured upon them of a mixture of sulpuric ether and alcohol. The mixture was composed of two parts of the purest sulphuric ether, and one part of absolute alcohol. The mixture was corked, well shaken up, and set aside. In that manner it stood over night. The next morning the contents of the tube were emptied out upon a weighed piece of muslin laid across a glass funnel; this was then folded up, placed between several layers of blotting paper, and well compressed in a screw letter press. In a few minutes the press was opened, the muslin taken out, and the pulp carefully scraped off and put back in the tube. One ounce of the same mixture as before was poured upon it, the tube was again corked up, well shaken, and set aside for three hours. It was then poured out upon the same piece of muslin as before, folded up, and returned to the press, taken out of it, and placed in a water oven till all the ether had evaporated. It was then left exposed to the air for an hour, and was weighed. The loss showed the amount of soluble gun-cotton present. The larger the loss the weaker the gun-cotton. Those samples in which the loss amounted to 13 per cent. and under were registered as "B.C.," and were sent to the Government. The Government fixed the limit at 15 per cent., but the company went 2 per cent. lower. Where the loss exceeded 13 per cent., the sample was registered as a regulation one, and was reserved for mining and sporting purposes. The loss of the samples rarely exceeded 14 per cent. The heat test, which decided whether the poachers had been perfectly washed, was divided into three distinct processes. Two of them were performed in an oil bath made of sheet copper of a certain size and shape. Nine samples often came up daily, and there were little card trays numbered from one to nine. If sample No. 6 came up it was taken up, set in a tray marked No. 6, and placed on the top of the oven. When a sample was thoroughly dry, it was set aside to cool to the common temperature of the air for one hour. At the end of that time some perfectly clean test tubes were got ready; they were 6 in. long and $\frac{1}{2}$ths of an inch in diameter. Two of these were fixed into two of the holes in the oil bath, a small portion of the samples of the gun-cotton was dropped into each of the two tubes, and the oil bath was then heated by gas to a temperature of 310°. The tubes were then drawn out, rapidly wiped, and looked into. The moment the slightly yellow vapour was seen in the tubes, the fuming point and its temperature were entered. If the fuming point was below 325° the sample was condemned for the present, and ordered to be re-washed. If it passed the Government point of 320°, a small bit of card was laid upon the top of each tube, the tubes were put into the bath, and the thermometer was again watched. When the thermometer got up to 340° an explosion was to be expected, and the precise degree of the thermometer was registered when the explosion happened. As soon as the explosion happened another small quantity of cotton was dropped into the tubes. Each sample had a double trial, and there were three or four grains in each tube at once. When the explosion happened it would be sometimes as sharp as a pistol shot. When the first explosion had occurred a fresh portion of gun-cotton was dropped into the empty tube from the same sample, and it always exploded a few degrees higher than the first time. Any sample exploding at under 350° would be condemned. The second explosion was expected to be at least 8° higher than the first. The more rapidly gun-cotton was heated, the greater the temperature it could bear. The standard for the first explosion was fixed by the Woolwich regulations at 343°, but Mr. Eustace Prentice fixed it at 350° for the purpose of greater security. The explosions were very frequently at 360°, and even above that. The result of the testing was telegraphed to the gun-cotton works by Mr. Baxter, the company's book-keeper. Every sample had to undergo another heat test. A small and shallow oil bath was used, in which one tube and a thermometer were fixed. A small portion of a sample of gun-cotton was put into the test tube, and above it was suspended on a glass hook a small portion of iodised test paper, which was prepared by washing over paper with a mixture of solution of starch and iodide of potassium. This piece of test paper was carefully wetted with distilled water, so that the upper part was wet and the lower part dry. The height at which the paper was suspended was regulated by a ring of vapour from the gun-cotton, which appeared in the test tube. When the thermometer had risen to about 190° a faint brown line of colour made its appearance across the test paper where the dry and the moist part bordered upon each other. If the faintest tint of colour appeared below 190°, the sample was condemned. These were all the ordinary tests applied, but special tests were occasionally applied to show whether the cotton was properly converted. One special test was to burn a quantity of gun-cotton to ashes and see what weight of mineral matter it left. The heat test, witness stated incidentally, should be carried through as nearly as possible in half an hour. Another of the special tests was known as the alkaline test. A certain quantity of carbonate of lime was only allowed in gun-cotton; if too much were put in it would be regarded as an adulteration. Hence a test was adopted. A few special samples of gun-cotton were left in witness's office; none of them had ever exploded although subjected to the high temperature of the laboratory.

At this stage of the proceedings the inquiry was adjourned to August 25th—this day.

PUMPING ENGINES AT BRUNSWICK.

THE works for the supply of water to the town of Brunswick—a town having a population of about 50,000—were commenced in the spring of the year 1863, and were completed in 1864. The supply is taken from the river Oker which rises in the Hartz mountains and the water of which possesses the usual qualities good and bad of a mountain stream. Thus during heavy rains and after the melting of the snow this water carries with it much stony débris, sand and vegetable detritus, and these matters it is, of course, necessary to remove by filtration, for which purpose there has been constructed a large filter exposing about 377,000 square feet of surface.

From the filter bed the water flows into a pump-well, whence it is raised by the pumping engines, of which we publish a two-page engraving in the present number, these engines lifting it to a height of 164 ft. above the normal level of the river. As will be seen from our engravings the pumping machinery consists of a pair of horisonal condensing engines each working a double-acting pump direct. The two engines are coupled and they are fitted with a variable expansion gear.

The river Oker traverses the town in several branches and the water from it is led to a reservoir situated by the side of the goods station from whence it flows through a pipe 17¼ in. in diameter and 790 ft. long, to the filter bed. From the filter bed the water is conducted through a main of the same diameter as that just mentioned and 230 ft. long, to a pump-well 21 ft. 4 in. in diameter, situated by the side of the engine house, whence it is raised to the summit of a water tower adjoining the building, the height of lift being as we have said 164 ft. above the normal level of the river. The highest flood level is 14 in. above, and the lowest water 3 ft. 6½ in. below the normal level just mentioned; this lowest level being 5 ft. 1½ in. below that of the engine room floor.

The daily consumption of water is at present about 1,100,000 gallons; but the engines are capable of furnishing a supply of double this amount, or about 2,200,000 gallons daily if required. The engines are driven at speeds varying, from 5 to 30 revolutions per minute, and they are supplied with steam by boilers worked at a pressure of 50 lb. per square inch, the point of cut-off being usually at about half stroke, a very late cut-off for such engines if economical working be an object. The price at which the water is retailed is about 2.72d. per 1000 gallons.

Referring to our two-page engraving, and also to the transverse section on page 118, it will be seen that the engines are fixed on a solid masonry foundation at a distance apart of 15 ft. 5 in. between their centre lines. The steam cylinders are 25½ in. diameter by 3 ft. 5½ in. stroke, and each piston rod, which is 4 in. in diameter, is continued through the back cylinder cover, and coupled direct to the rod of a double-acting pump 16¾ in. in diameter. The cylinders are steam jacketted, and well cleaded, the supply of steam for the jackets being drawn direct from the boilers; and each cylinder is securely fixed to a bed-plate which extends the whole length of the engine and also carries the pump. The distance in each engine from centre of crank shaft to centre of length of steam cylinder is 16 ft. 3 in., and that between the centres of the steam and pump cylinders 12 ft. 1 in. The length of the connecting rods is 9 ft. 8 in., and the diameter of the fly-wheels 17 ft. 4½ in. The flywheel shaft is 11 in. in diameter at the wheel seats and 8¾ in. at the bearings, the length of the latter being 11¾ in.

Steam is conducted to the engines by the pipe, L, this pipe communicating with the branches, K and H, which lead the steam to the ends of the cylinders. The admission and exhaust valves are of the equilibrium type, one of the admission valves being shown in section by Fig. 6, while Fig. 7 represents the arrangement of cams and levers by which the valves are lifted. The cams for actuating the valves are carried by a shaft, E, which is driven from the flywheel shaft by bevel gearing, as shown in the plan. The cams for lifting the exhaust valves are fixed on the cam shaft, but the cams for actuating the steam valves are moveable longitudinally, and their form is such that by so shifting them the point of cut-off can be varied at will. The cams are moved by the aid of the endless screws, V, the shafts, X, and the rods, Y.

The exhaust valves, M, communicate by the pipe, N, with the condenser, O, this latter being of the injection type. The air pump, P, which is 17½ in. in diameter, with a stroke of 2 ft. 1½ in., is worked by the arm, S, which is fixed on a rocking shaft, on which there is also fixed the lever, T, the upper end of this lever being coupled by links to the main cross-head. The feed pump, Q, which is 11½ in. in diameter, with 1 ft. 7½ in. stroke, is driven from a prolongation of the arm, S, across the rocking shaft, as shown.

The arrangement of the pump cylinders with their valves, and the manner in which they are fixed to the framing of the engines is clearly shown by the longitudinal section in our two-page engraving and by the transverse section on page 118. The pump barrels are, as we have stated, 17¾ in. in diameter, and each is contained within a larger outer cylinder 33½ in. in diameter, this outer cylinder communicating with the valve chests, as shown in the sections. The valves are of the double-beat class, the suction valves, *d* and *e*, having seats of such size as to leave a clear water-way 12.59 in. in diameter, while the delivery valves, *d'* and *e'*, are also of the same dimensions. One of these valves is shown in section by Fig. 2 on page 118. The suction pipes, *f*, leading to the pump-well are each 13½ in. in diameter, and each is furnished with an air vessel, *g*, as shown in the longitudinal section.

The delivery valve boxes of each pump communicate with each other by a passage, on the top of which is placed an air vessel 18¾ in. in diameter, by 5 ft. 3 in. high, while from the passage just mentioned, the water traverses a belt around the pump barrel to the delivery pipes leading to the main air vessel, common to the two pumps. The arrangement of the delivery pipes and passages is clearly shown on the left-hand half of the transverse section on page 118. The delivery pipes connecting the pumps with the main air vessel are each in two portions, that portion next the pump being 12.59 in., and that next the air vessel 13.79 in. in diameter. The two portions are connected by a stuffing-box, which permits expansion and contraction to take place freely, and close to the stuffing-box is a sluice valve, *m*, by which the communication between the pump and the air vessel can be cut off. The mouth of each delivery pipe, also within the main air vessel, is fitted with a pair of flap valves, as shown in the transverse section, Fig 1, and the detail view, Fig. 3 on page 118.

The main air vessel, which is 4 ft. 11 in. in diameter at the bottom, and 15 ft. 5 in. high, is formed of wrought-iron plates and like the smaller air vessels, is fitted with a glass water gauge to show the water level. From the main air vessel the water passes by the pipe, *r*, 13.78 in. in diameter to a vertical pipe, which conducts it to the top of the water tower, which has already been mentioned as adjoining the engine house, and from which it descends again to supply the town. The chimney belonging to the boilers, we may mention, traverse the centre of the water tower.

The cost of the Brunswick water works, with the pumping engines, has been as follows:

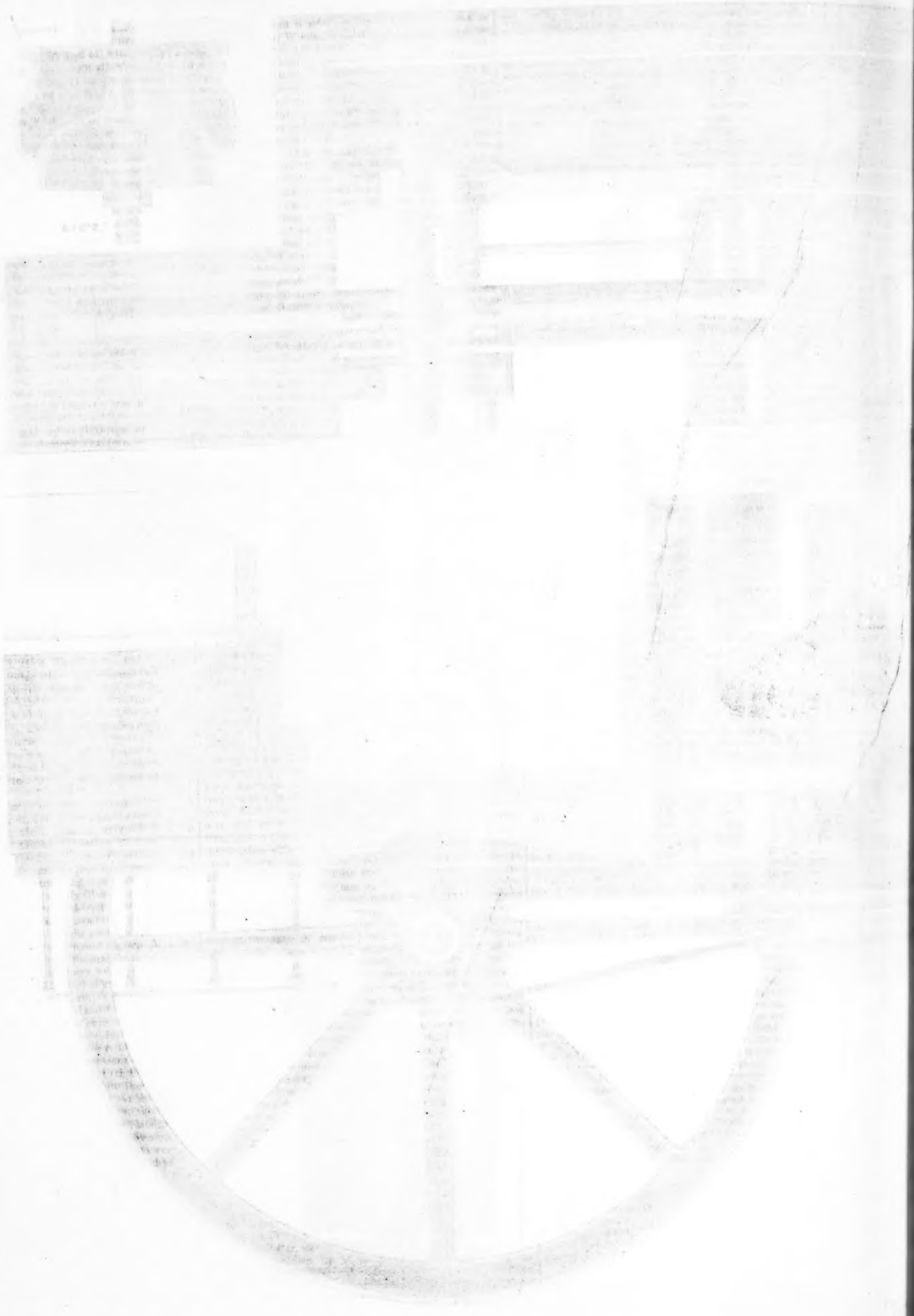
	£
Cost of 78,740 ft. of cast-iron pipes, including transport and testing ...	10,757.85
Laying pipes	3,404.1
Pipes conducting the water to the filter and to the engines, including testing and laying	1,395.6
Paving	810.0
300 plugs and 92 sluice valves	2,211.3
Stand pipe, &c., at the Château d'Eau ...	860.55
Construction of filter	2,733.79
„ of pump-wells	222.0
Pumping engines and boilers	3,702.6
Fixing engines and pipes at Château d'Eau	252.15
Construction of engine and boiler-house, with tower	10,689.90
Miscellaneous expenses	984.0
Cost of superintendence, &c.	914.69
	£38,998.47

A storage reservoir is to be provided for the purpose of maintaining a supply of water in the event of failure, to the engines, but this has not yet been constructed. In concision, we should state that we are indebted to the *Zeitschrift der Architecten und Ingenieur-Vereins zu Hannover* for particulars of the engines we have described.

GRAND TRUNK RAILWAY OF CANADA.—The work of extending the Grand Trunk Railway along the wharves at Montreal is proceeding briskly. Engines specially adapted for the extension are being made in Philadelphia.

THE CERBERUS.—The Treasurer of Victoria has written to the Governor of that colony bringing under His Excellency's notice the high opinion entertained by the Victorian Government of Captain Panter's services in bringing out the Cerberus. The Treasurer suggests that as Captain Panter has been promoted in the colonial navy the Governor should recommend the Imperial Government to give a similar recognition of his services.

CHESAPEAKE AND OHIO CANAL.—A recent break on the Chesapeake and Ohio Canal along the "five-mile level" is attributed to the operations of musk-rats. This destructive pest has within the last few years largely increased in numbers along the lines of the Chesapeake and other canals, and it is feared that breaks may occur at other points. On the Mississippi, quite an insignificant enemy, the crawfish, is said to be giving continual trouble by burrowing in the levees. The holes made by crawfish have to be promptly stopped up.



HORIZONTAL PUMPING ENGINE

(Page 124.)

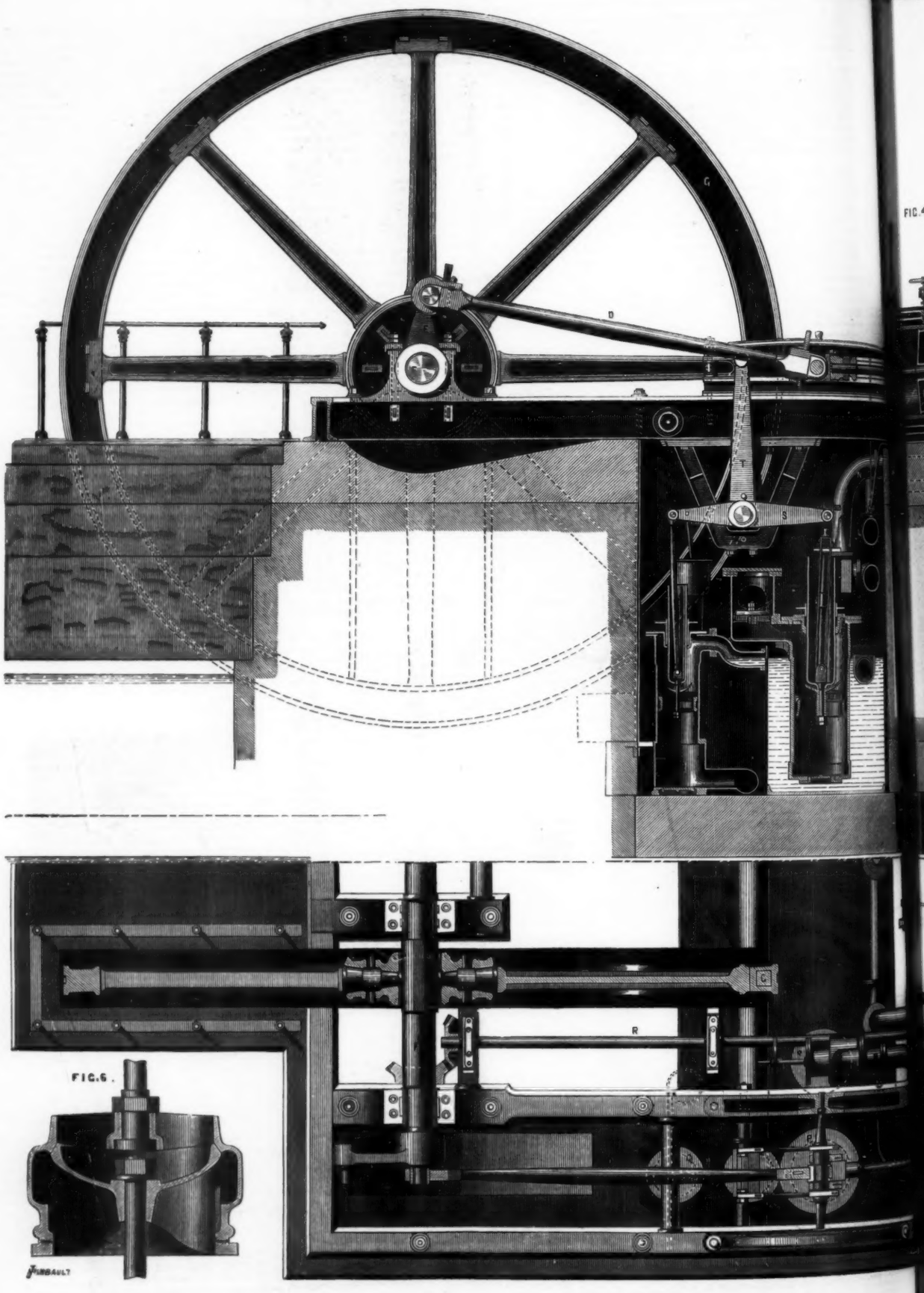


FIG. 4.

FIG. 6.

J. HERBAULT

124)

FIG. 4.

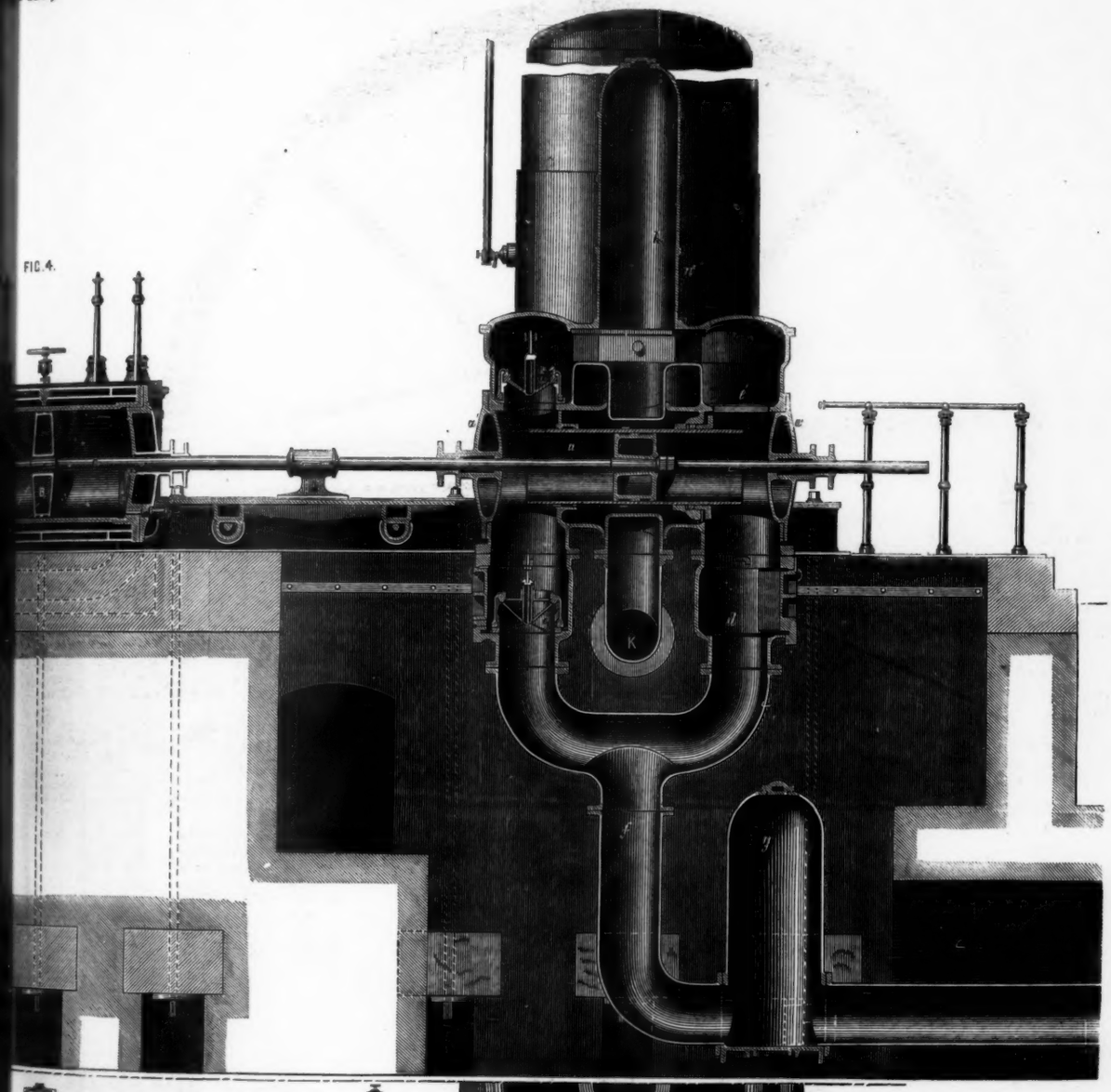
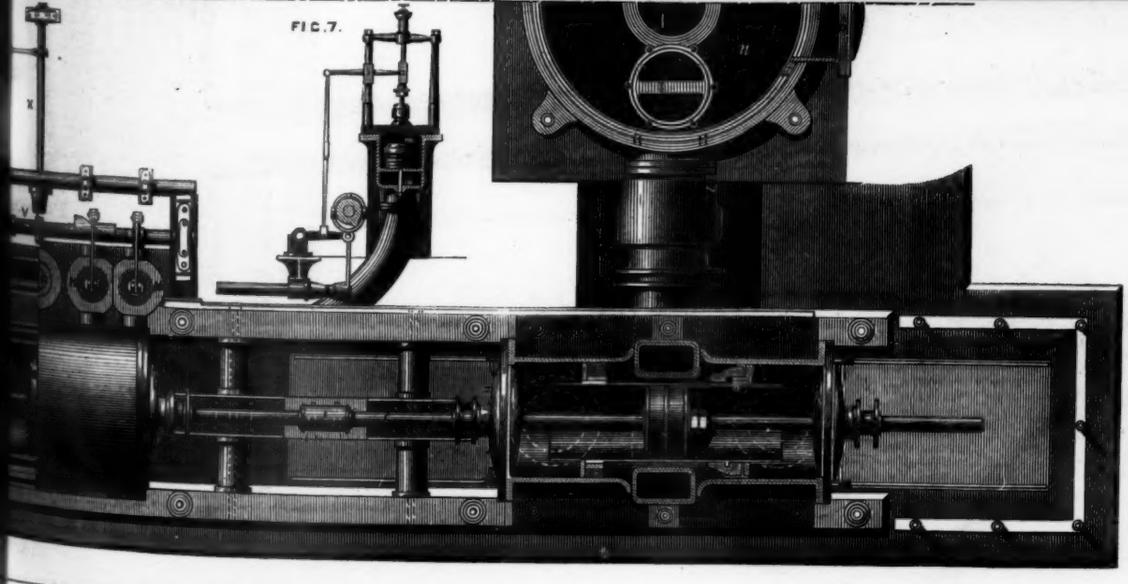


FIG. 7.



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CONTENTS.

	PAGE		PAGE
Bauschinger's Indicator Experiments on Locomotives	117	Technical Dictionaries	126
Walker's Fireproof Flooring	117	Education at Coopers Hill	126
Temporary Works Carried out by the German Field Railway Corps	119	French Steam Navigation	127
The British Association	120	Notes from Paris	127
Indian Engineering Examination	121	Random Notes from Northern India	128
Blast Furnace Cinder	121	Notes from the South-West	128
Titanium and Iron	121	Notes from the North	129
Iron Railway Sleepers	121	Notes from Cleveland and the Northern Counties	129
Fore Part of H.M.S. Glatton	122	English Steam Fire Engines in America	129
Railway Brakes	122	Foreign and Colonial Notes	129
Recent Patents	123	Dahl's Puddling Furnace	130
The Stowmarket Explosion	123	Railway Gauges	131
Pumping Engines at Brunswick	124	The Albert Bridge	132
Locomotive Economy	125		

ENGINEERING.

FRIDAY, AUGUST 25, 1871.

LOCOMOTIVE ECONOMY.

IT is not very many years since locomotive engines had to be reckoned amongst the most economical power producers in use. The high-pressure steam with which they have long been worked, their high piston speeds, and the generally good proportions of their boilers and valve gear, gave them, at the time to which we refer, great advantages over most of their competitors, and the consequence was, that, as we have said, the locomotive held in those days a high position amongst engines generally. At the present time, however, matters are greatly changed; high steam pressures and high piston speeds are no longer almost peculiar to locomotive practice, while the development of surface condensation and the compound system, have combined to assist in the production of engines capable of developing a horse power with a consumption of fuel amounting to less than two-thirds, probably, of that required in the best locomotive ever built. Even portable engines—long regarded with something not very different from contempt by railway engineers—have, under the fostering care of the Royal Agricultural Society, improved of late years to an extent which renders them, in a large number of instances, more than a match for the locomotive as far as economy of fuel is concerned; and only a few months ago (*vide* page 333 of our tenth volume) we took occasion to point out that, in some respects, locomotive engineers might now advantageously adopt, with certain modifications, the practice of portable engine builders. Under these circumstances it appears to us worth while to consider the causes which have contributed to this result, and to explain briefly some points connected with locomotive economy, which we have reason to believe are not so generally understood as they deserve to be.

We have, on former occasions, when writing on steam engine economy, always been careful to point out that the real value of any improvement applied to a steam engine is dependent in a most important degree upon the nature of the work which that particular engine has to perform. We have shown that the greater the number of hours per annum that an engine is in steam the greater is the expenditure which it is justifiable to incur to obtain a given percentage of reduction in the consumption of fuel, and *vice versâ*; and we have explained how an improvement which, in one instance, might be adopted with considerable profit, would, if resorted to in another instance, actually cause a monetary loss. Now there is no class of engine to which these arguments apply with greater force than to a locomotive. The average number of hours per annum during which a locomotive is actually running is small, the average power developed when running is considerably below the maximum power which the engine is capable of developing, and hence the total number of foot-pounds of work developed per annum and the total cost of fuel per annum are both very small in proportion to the cost of the machine. How small this annual cost of fuel per locomotive really is, is probably known to but few beyond those specially concerned in railway management, and we therefore subjoin a Table containing some data on this point, which we believe will be interesting. The figures given in this Table, we may remark, have been calculated from the returns of ten of our principal railway companies for the last six months of the past year, the "average cost of fuel per engine per half year" being obtained simply by dividing, in each case, the total cost of coke and coal for the half year by the number of engines possessed by the company.

Name of Railway.	Average number of miles ran per engine during half year.	Average cost of fuel per engine per half year. £	s.	d.
London and North-Western ...	8,140 ...	48	19	4
Great Western ...	8,833 ...	52	17	5
North-Eastern ...	9,141 ...	88	11	8
Midland	10,740 ...	79	0	0
Great Northern ...	9,795 ...	67	12	9
Great Eastern ...	9,797 ...	73	2	3
South-Eastern ...	8,334 ...	108	0	0
London, Brighton, and South Coast	9,961 ...	138	4	11
London and South-Western ...	12,093 ...	111	19	3
London, Chatham, and Dover ...	10,221 ...	131	0	11
Means of above for half year ...	9,705¼ ...	89	8	10
Means per engine per annum ...	19,411 ...	178	17	8

In round numbers we may call the average cost of fuel per engine per annum 180*l.*, and if we take the mean gross cost of an engine as 2400*l.*, we see that the cost of fuel really amounts to an annual charge of but 7½ per cent. on the cost of the machine. In other words, if it were possible, by doubling the cost of construction, to render a locomotive capable of doing its work without any fuel whatever, the saving would, on the average, only pay interest at the rate of 7½ per cent. on the extra outlay, even if we suppose that this outlay involved no increase in the allowance to be made for depreciation. In the case of the London and North-Western Railway, moreover, the interest on the additional outlay, under the circumstances above supposed, would amount to but 4 per cent., a very unremunerative result. In the above instances we have supposed, as we have said, that an extra outlay on the engine involved no extra charges for depreciation; but in reality this, of course, would not be the case. There are, probably, extremely few improvements which are capable of being applied to a locomotive for the purpose of obtaining greater economy of fuel, which will not render necessary an additional allowance for depreciation fully proportional to the increase they cause in the cost of the engine, and if we take this charge for depreciation as 10 per cent., and the interest on extra capital invested as 5 per cent., we shall have a total annual charge of 15 per cent. on the cost of any such improvement as we have supposed, which must be cleared off before the use of the improvement results in a profit. Let us, for instance, suppose a locomotive to be fitted with some fuel-saving arrangements involving an additional cost of 200*l.*; then these arrangements would have to save per annum a sufficient amount of fuel to pay an annual charge of 30*l.* (20*l.* for depreciation and 10*l.* for interest), before the use of these additional appliances was attended with any profit to the railway company to which the locomotive belonged. But 30*l.* is about one-sixth of the average total annual expenditure for fuel, and therefore, fuel-saving arrangements, such as we have just supposed to be applied, would have to effect a reduction in the consumption of fuel of at least 16⅔ per cent. in order to avoid their use being attended with an absolute loss. In the case of the London and North-Western Railway, where the average cost of fuel per engine per annum is less than 100*l.*, the 30*l.* above mentioned would represent the cost of rather more than 30 per cent. of the annual consumption of fuel, and the fuel-saving appliances costing 200*l.* would, therefore, have to reduce the consumption more than 30 per cent. before they became profitable.

Assuming that the above mentioned allowance for depreciation is fairly correct, and making a slight additional allowance for incidental expenses mostly attendant upon the employment of additional parts on an engine, we may consider broadly that any fuel-saving appliances added to a locomotive must, to avoid their use being attended with loss, effect on the average a reduction of fuel amounting to 1 per cent. for each 10*l.* of their original cost. Now, with this fact before us it is easy to understand why simplicity has always been regarded as a cardinal virtue in a locomotive, and why so few "refinements" have ever been found profitable when applied to it. Notwithstanding this, however, there are a few fuel-saving appliances which, although involving some additional cost, might certainly be very generally employed with advantage. The most important of these are steam jackets for the cylinders, and a simple arrangement of feed-water heater. With the increased pressures of steam now in use steam jackets are more than ever a necessity for economical expansive working, and we have on a former occasion (*vide* page 333 of our tenth volume) pointed out how they may be very readily applied to locomotives. Feed-water heaters are, we are glad to say, coming into use on several lines, and we hope to see their employment extended.

So far, in speaking of locomotive economy we have considered an engine merely as a power-producing machine; but in reality a locomotive is far more than this. Besides being a steam engine proper it is a carriage on which the engine and the stores of fuel and water for working that engine can be transported from place to place, and this carriage portion of the machine exercises a most important influence upon the question of maintenance. Speaking in general terms, the average total expenditure per locomotive per annum on our main lines of railway may be taken as about 660*l.*, this sum being divided out about as follows:

	per cent.
Fuel	28
Wages and other running expenses	32
Repairs and renewals	35
General charges	5
	100

Now if we still assume the average value of a locomotive to be 2400*l.*, we shall see that the mere annual charge for interest on this sum taken at 5 per cent. will amount to one-third of the whole annual expense of working and maintenance, or, in other words, that it will be nearly equal to the whole cost of repairs and renewals. If now by any modification or improvement in construction, we suppose it possible, without increasing the cost, to make one engine do the work which it at present requires two to perform, there would at once be effected a saving, due merely to the reduction of interest charge, equal to that which would be obtained by reducing the consumption of fuel to two-thirds of its present amount, while there would be the further advantage that the saving resulting from any given improvement in the economical production and use of the steam would be proportionately increased. It is here that we have the key to the true method of securing locomotive economy and an explanation of the fact that the most successful locomotive superintendents have been those who have paid the greatest attention to the production of a thoroughly durable engine at a moderate cost. It is thus that locomotive engineers have of late years thrown themselves open to the charge of paying more attention to what may be termed locomotive manufacture than to the development of the engine as an economical steam user; but a careful consideration of the facts of the case shows that in doing this they have been consulting the best interests of those for whom they act. The greatest aids to locomotive economy are, in fact, such improvements in con-

struction as enable the engines to be worked for long periods without entering the shops for repairs, and such arrangements as enable the engines to run a large annual mileage, without, however, interfering with the proper intervals for cleaning and general overhauling. In fact, so long as the latter points are attended to, the harder locomotives are worked the better will be the economical results. It is impossible, within the scope of the present notice, to do more than direct attention to the general principles we have endeavoured to explain, but we intend in future articles to speak of some of the leading points of detail upon which locomotive economy in a great measure depends.

TECHNICAL DICTIONARIES.

THE "international" tendencies of the present day have not been without influence on the literature of the period, and accordingly we find that within the last few years several works have been put forward which may be classed under the general heading indicated by the title of this article. Pending the adoption of the universal language, which is we devoutly hope very far off, certain individuals more or less qualified (generally less) have set themselves to compile vocabularies giving the equivalents of technical terms in various languages. We do not propose to enter upon a regular review of any of these works, but intend simply to make a few suggestions for the benefit of authors who think they have a call to enter on the preparation of a Technical Dictionary.

The first and most important requisite of such a book is that it shall present a faithful list of the words in use at the time of publication, and not be over-burdened with obsolete and erroneous terms belonging to a past generation. It is for this reason that all dictionaries which seek to recommend themselves as containing so many thousand "additional words" should be regarded with suspicion. It is quite true that obsolete words should appear in what we may call the "first place," for the benefit of those who may be reading old books. For instance, in a good English-German-French dictionary, we should expect to find the word "fire-engine," as denoting the machine now called a "steam-engine," of course with a note to prevent the unwary use of the word by a foreigner writing English. Even so late as 1793 a tract was published under the title of "Introduction to the art of making machines *vulgarly* called steam-engines," thus showing that the word "steam-engine" had by no means gained for itself admission into all circles at the end of the last century. It is, indeed, probable that "steam engine" and "fire-engine" were used indifferently to denote the same thing for many years after that date. We should *not*, however, expect to find in the French part of our imaginary dictionary the word "fire-engine" given as an equivalent for *machine-à-vapeur*. Moreover the author should be careful to point out, if he can, the subtle distinctions between such words as "road steamer," "steam carriage," "road locomotive," and "traction engine." It is here worth noting that "steamer" was once applied indifferently to machines for moving through the water and to those suitable only for locomotion on land. It was probably never used by authors in the latter sense, but the present writer well remembers hearing it applied to locomotives by country people many years ago. We have never yet seen a dictionary which attempted to discriminate between "mechanic," "mechanician," "mechanist," and "machinist." The first of these words has in London a local signification, by which it is made to include almost every one whose trade is mechanical, but we fancy that a bricklayer in the North of England would be rather surprised at being called a "mechanic." Again "machinist" has, since the introduction of the sewing machine, obtained an entirely new meaning. It has also a special signification behind the scenes of a theatre. Similar varying shades of meaning also exist in French and German. For instance, one of the meanings of *mécanicien* is "engine-driver," and we occasionally see in newspaper accounts of French railway accidents that "the mechancian escaped unhurt." We may perhaps one day meet with a literal translation of *chauffeur*, the French designation of the driver's mate, the "stoker" or "fireman." After all it would not be so very foreign to the language, as the word still lingers here in that mysterious functionary of the Court of Chancery, whom it was once our privilege to behold in the flesh, we allude to "Mr. Deputy Chaff-wax," whose duty it is to heat *—chauffer*—the wax for impressing documents with the Great Seal. However pedantic such an assertion may appear to the "practical man," we shall never have a technical dictionary worthy of the name unless the compiler brings to his task a certain amount of etymological and philological skill. He must be prepared to notice the peculiar circumstances which influenced the technical terms in new branches of industry. Take an example. It is interesting to note that railways on their first introduction were intended to be a sort of modified "King's highway." All the old railway Acts contain clauses providing for the running of private trains. The term "*railroad*" (now discarded here but still in general use in the United States) shows this, to a certain extent, and the analogy may be carried still further by the terms "driver," "guard," "coaches" (as the carriages are still called by the railway employés) and "wagons." Even so late as 1839 we find the author of a book on "Roads and Railroads, Vehicles and Modes of Travelling" saying—"There is a class of stage coaches (if the term be properly applied to them) which have come much into use within a few years; we mean those employed on the various railroads. These vehicles have never to make any of those sudden turns which are required on common roads . . . . some are shaped like private carriages."

As in general literature so in technical literature, it is entirely beyond the power of any dictionary maker to influence the use or disuse of any particular phrase or word. The Dictionary of the French Academy is sufficient proof of this. It may also be said that a new word is never introduced by a dictionary, but when the necessity for it becomes very pressing it springs up mysteriously, and if it happens to suit the public taste is straightway adopted into the language. "Telegram" is a case in point; but "Bessemerise," founded on the German "Bessemern," which signifies the carrying out of the Bessemer process, has scarcely survived its birth. The word "re-railing" in the sense of replacing a railway carriage on the rail after an accident is vastly convenient, but has not been generally adopted. Again, we are not yet permitted to say, without a charge of using an Americanism, that two trains "collided." American writers are not troubled with the conservative scruples which hamper us with regard to the invention of new terms, and no German is ever at fault, in consequence of the marvellous facility with which compound words may be formed in that language. But as we have said before, it is not the province of the compiler of a technical dictionary to invent new words, a maxim which some would do well to bear in mind. In many works of this kind the authors appear to have thought that their task was ended when they had ransacked previous authors, good, bad, and indifferent, and simply arranged in order the words so obtained. No note is taken of the gradual change which all language is continually undergoing, and the most ridiculous blunders are propagated. They never seem to think that it is necessary to read modern authors of established reputation for the purpose of recording new words or old words used in a new sense. At the present day, when periodical literature occupies so prominent a position, it is obvious that this search must be made principally in the technical and scientific journals. If any one would only take the trouble to read over a translated article in a leading French or German periodical (he will have no difficulty whatever in finding one), and, with the English original before him, note the rendering of all the technicalities, we can promise him that they will be very different indeed to anything which he will find in the very latest and best technical dictionary. We venture, also, to call the attention of intending lexicographers to another profitable mine which has never been worked as it ought to be. We allude to illustrated trade circulars and price lists, such as Barras and Blackett's "Sheffield Standard List," or Appleby's "Illustrated Handbook of Machinery." By a comparison of these with foreign lists of a similar kind an immense number of words might be obtained which have never found their way into any technical dictionary. We will venture to say that the advertisement columns of this very number contain at least fifty terms which an unfortunate translator might seek for in vain in his favourite lexicon; or, if he did find them, the majority of the renderings would be sure to belong to the last generation, or perhaps to no generation at all.

In the absence of any reliable technological dictionary the only resource left for a translator, when the context does not clearly indicate the meaning, is to read up the subject in a work written in the language from which he is translating. In this way one may generally succeed with patience, in extracting the meaning even of the most cloudy German author, and that is saying a good deal. We say generally, because there are some cases in which no English equivalent exists, as, for instance, in metallurgical and other processes which are either quite new or are confined strictly to a particular locality. These are real difficulties out of which all existing dictionaries are unable to help us.

We have refrained from mentioning any dictionaries by name, but should our remarks meet the eye of any industrious compiler, we take the liberty of suggesting that he should discard at least three-fourths of the matter which he has accumulated from other authors. A careful revision of the remaining fourth, according to the principles we have laid down, will probably lead to a still further reduction of quantity, and to the improvement of the quality of his work. It should always be borne in mind that a hundred words picked up in the workshop or from writers of authority are worth a thousand which simply embody the accumulated errors of dozens of ignorant compilers.

EDUCATION AT COOPERS HILL.

BRIEFLY stated, the education which it is proposed to give to students at the Indian Engineering College at Coopers Hill will combine the theoretical and practical training required for the manufacture of them into civil engineers; at least, this is the theory of the proposed plan, as sketched out in the pages of the college prospectus. The manner in which it is to be carried into practice has been sketched out by the gallant Principal of the college in his speech of the 5th of August last, at the opening ceremony, which we described a few weeks back. As the very object for which the college has been established is to afford a better education than can at present be obtained elsewhere in this country, a high standard of qualification has been laid down, which, it is hoped, may be realised in practice. In such a college as Coopers Hill is intended to be, it is by no means easy to draw the line between the subjects which should be pursued, and those which may be neglected. It is obvious, however, that time would not permit, neither would it be desirable, even if practical, to cram too many subjects into the heads of the students, lest the result should be that they obtained a smattering of many, and real proficiency in but a few, if any. Drawing, surveying, mathematics, mechanics, and the principles of construction are useful of course; but for the accomplished engineer education clearly must not stop there. A man who has to deal with materials of all kinds ought not to be satisfied to remain in ignorance of the essential properties of bodies, and this necessarily involves some acquaintance with the general laws of chemical philosophy, and their application to various forms of matter. The same thing holds good equally with respect to heat and electricity, magnetism, mineralogy, and geology. The experimental and natural sciences have an especial and practical value to the engineer in India, because he has to deal much with the conversion of raw material, and there is not the same subdivision of labour there that exists in England. In India, where the organisation of trade is still in a primitive condition, and work is carried on at a distance from manufacturing centres, an engineer not only has often to run alone almost as soon as he arrives there, but has generally to go straight to Mother Nature for his materials, to dig and burn his own lime, to make his own bricks, and often to fell his own timber. A knowledge of the chemical principles involved in the composition of mortars and cements is in such cases simply invaluable, as is also a knowledge of the principles which guide him to the place where suitable stones are to be found—in other words, geology and mineralogy. Very properly, great importance is attached to an acquaintance with the Indian language; for how can an engineer exercise efficient control and supervision if he be unable to make himself intelligible to his workpeople, or to understand what they say? With a knowledge of the language of the people of India will also be instilled, to a certain extent, an appreciation of their customs and habits. "It has been well said," remarked Colonel Chesney, in his opening address, "that those who know the people of India best esteem them most, and the converse proposition unquestionably holds good—those persons will always be found most pronounced in their con-

tempt for 'the natives,' and most ready to declare that Indian researches are flat and unprofitable, who know nothing whatever about them."

So far for the theoretical, or book learning to be pursued at the college, and, in a general sense, the programme appears to include about all that need be especially taught there. But precisely the same subjects form part of the curriculum at existing places where engineering is taught, and which, as has been so repeatedly affirmed, have failed to produce qualified men in sufficient numbers for the Indian service. The true test, then, will be the quality of the education given—not the quantity. It cannot be denied that equal facilities exist elsewhere as here for imparting this knowledge. Are we to assume, then, that they are not properly made use of? We think not. It has, however, been the misfortune of the Indian Government that they have not offered terms sufficiently attractive to secure the best men. The terms offered have now been greatly improved, and hence we may expect that a better class of men will come forward for admission to the college, than have hitherto, as a rule, sought admission to the Indian Public Works Department by means of the open competitive examinations. With good raw materials, a finished article possessing a high degree of excellence will always be turned out by skilful workmen; and it will, therefore, be as much the fault of the professors as of the students if Coopers Hill College does not fulfil the expectations that have been justly encouraged of it. We have yet to consider the practical part of the engineer's training here, and it is in that branch that the greatest difficulties will be found to present themselves. With respect to surveying, unusual facilities exist in the grounds attached to the college, and in the surrounding country for education in that branch of an engineer's duties in which, judging from the results of past competitive examinations the existing colleges are plainly deficient. To anticipate any failure to impart the requisite knowledge of surveying here, would be at once to confess our want of confidence in the merits of the professor of surveying, and this is the last thing we should feel justified in doing. It is, however, in that part of the practical training which, from its very nature, cannot take place in the neighbourhood of the college itself, that most difficulties are to be apprehended; but these, it is to be hoped, will not prove insurmountable. Colonel Chesney admits the importance of this when he observes that, "in India, the engineer will very likely spend a great part of his time in out-of-the-way places, dependent on his own resources." In such a case, how is a man to act with ability if he has not first learned to do so from practical experience gained elsewhere, and India is certainly not the place to begin to acquire that experience. With nothing to fall back upon besides his own resources, an engineer would be lost in the event of any unforeseen emergency arising in the course of actual construction if he had nothing beyond theory and book-learning to guide him. How many difficulties arise, for instance, in the construction of hydraulic works, which practise alone can teach him to overcome? In the construction of irrigation works, the past experience of engineers in India has plentifully provided a proof of the necessity for such practical training. This, then, though outside the bounds of the immediate college course, has to be provided for by the college authorities, and it will be only by establishing a thorough understanding with engineers in extensive practice in this country, that the difficulty can be surmounted.

FRENCH STEAM NAVIGATION.

THE French General Transatlantic Steam Navigation Company, in common with all other French joint stock enterprises, was terribly tried by the war which weighed so cruelly upon France between July, 1870, and March, 1871. The lamentable Communist insurrection will also exercise, of course, an adverse influence upon the current year's accounts. The first half of 1870 was attended with tolerably remunerative results to the company, but its undertaking soon experienced the effects of the severe shock given to every branch of French industry and enterprise by the Prussian war. The investment of Paris which took place early in September and the invasion of the eastern and northern departments of France paralysed the exports of manufactured goods which supported the company's outward voyages, and also greatly reduced the importation of exotic products which formed the mainstay of its return passages. The movement of passengers to France was also almost totally suspended. In order to economise the resources of the treasury, and to enable them to be devoted to the expenses of the war, the delegation of finance established at Tours towards the close of September called upon the representatives of the company to consent to a reduction in its postal services. In consequence of this reduction, which was agreed to by the council of administration, only one monthly voyage was as from October made upon the Antilles line, and as from December upon the New York line. At the same time, the steamers of the company engaged upon the Havre and New York line were required to bring cargoes of arms and munitions of war from the United States; seven of these cargoes were brought over in the last quarter of 1870, and four in the first few months of 1871. In consequence of this special business on Government account, the measures of severe economy applied to every detail of the management, and the employment on the Antilles lines of ships of comparatively small size and limited coal consumption, the effects of the trials and difficulties to which the undertaking was exposed in the last autumn and winter were considerably attenuated. The receipts obtained from 47 voyages accomplished in 1870—namely, 26 on the New York, 12 on the Mexican, and 9 on the Colon lines—amounted to 405,642*l.*; and taking account of the fact that three less voyages were made last year upon the Colon line as compared with 1869, we find that the total falling off in the receipts last year did not exceed 8767*l.* The working expenses, exclusive of the insurance account, were considerably reduced last year, the economy realised being computed altogether at 49,317*l.* The largest proportion of this economy was obtained under the head of coal, in consequence of the more constant application to the great lines of two steamers with improved engines. Thus the whole expenditure for coal and oil amounted last year to only 202,226*l.*, as compared with 238,021*l.* in 1869, showing the large saving of 35,796*l.*

One of the steamers of the company was lost last year. This vessel, which was of 200 horse power and named the Darien, was charged with the intercolonial service from St. Thomas to Colon; she struck in October upon the southern coast of Cuba, and notwithstanding the efforts of the captain and crew she could not be re-floated. The passengers and crew were, however, saved without difficulty; and after providing for the loss the company's insurance fund still amounted to 117,693*l.* The company carried last year 17,500 soldiers on account of the French Government from point to point on the French coast; it also brought back to France from Germany in the course of the spring 17,000 French prisoners of war. In this last service ten voyages were made from Hamburg. The sums payable by the French Government for this military traffic will figure in the company's accounts for 1871. As regards the receipts and expenditure for 1870, it may be repeated that the actual receipts from the general service amounted to 405,642*l.* To this amount may be added the fixed subvention of the Government for the year, amounting to 348,754*l.* The directors also rely on receiving an eventual supplementary subvention of 80,000*l.*, which will increase the whole revenue of the year to 834,396*l.* The working expenses of the year were 612,516*l.*, leaving a profit of 221,880*l.*, which is, however, obviously dependent upon the receipt in full of the subventions of the State. After deducting from the profit of 221,880*l.*, the interest accruing on obligations and the amounts absorbed by sinking funds created to make good the capital absorbed in the company's fleet, the transformation account, &c., the final balance of profit remaining did not exceed 32,000*l.* The supplementary subvention of 80,000*l.* will not be granted to the company until, in accordance with a law voted in 1868, a detailed examination is made of the accounts by a commission appointed by the Government with that object, and whose duty will be to ascertain that the company did not realise a profit of 5 per cent. upon its share capital last year. There cannot, unfortunately for the proprietors, be any doubts upon this head; but in consequence of the other pressing matters to which the French authorities have had to devote their attention, it is only recently that measures have been adopted for the nomination of the commission. When the commission has concluded its examination of last year's accounts, and when the Government has paid its supplementary subvention then, and not until then, will there be any dividend for the shareholders in respect to the past year; and even when the dividend is at last forthcoming it will be only 2 per cent.

The company is reducing the cost of its fleet by the constant operation of a sinking fund, reserves, &c. At the close of 1869, the outlay in respect to the fleet was estimated at 2,194,398*l.*; and at the close of 1870, the total had been reduced to 2,158,370*l.* Allowing for the reserve accumulated it was even computed that the cost of the fleet did not exceed 1,717,637*l.* at the end of last year; and in the fifteen years during which the postal concessions of the company have still to run this sum will be reduced to 85,637*l.* if the reserves now made annually are continued at the same rate. A special transformation account opened in 1868, and comprising the cost of surface condensers and sundry changes carried out in the Washington, the Lafayette, and the Martinique, was only increased in 1870 by the amount of the outlay incurred on board the Guadeloupe in connexion with the substitution of high-pressure boilers for low-pressure boilers. The cost of certain works of a similar character carried out on board the Caravelle was not added last year, having been redeemed to the extent of one-half out of the current working expenses of 1870, while the remaining half will be made good in a similar manner during 1871. The balance at the debit of the transformation account is to be redeemed at the rate of 10 per cent. per annum. One of three new steamers ordered for the company's Pacific line has been delivered, and has made a trial trip to Mexico; this voyage, both in respect to the speed attained and the combustible consumed, was considered a highly successful one. The second of the three new steamers is expected to be handed over to the company this month (August), and the third will probably follow in October; the steamers have not, however, been launched within the prescribed periods, and the company has made some representations on the subject to the contractors. The sum to be paid for the three steamers is 268,000*l.* in round figures, and of this amount 187,709*l.* had been handed over at the close of 1870. The result of the past year's operations can scarcely be regarded as satisfactory to the proprietors, but allowance must be made for the grave difficulties of the moment and better things are now hoped for and relied on, both from the changes determined on in the company's fleet and the gradual revival of French commerce.

NOTES FROM PARIS.

PARIS, August 21, 1871.

ALSACE AND LORRAINE.

THE annexation of Alsace and Lorraine has imported into the industrial situation of France and of Germany a considerable perplexity, which just now occupies the attention of both countries. Out of 39 blast furnaces producing 281,000 tons of iron, which Alsace and Lorraine worked according to the statistics of 1867, 25 blast furnaces producing 205,000 tons are left to France and out of 28,500 acres of land producing 641,000 tons of ore 22,500 acres become German, and represent a production of 500,000 tons. We may add that the treaty of peace leaves to France 14 iron works, whose production amounts to 127,000 tons and 55,000 acres of coal lands, yielding 180,000 tons of coal annually.

France possessed 6,800,000 cotton spindles, representing per annum 80 millions of kilogrammes of thread. In these figures Alsace had 1,600,000 spindles. France had 80,000 looms, producing about 55,000,000 of kilogrammes of cotton fabrics; the treaty leaves in Alsace 35,000 looms, and 22 millions of kilogrammes of fabrics, or more than a third of the total amount. Now, after the 1st of September next, according to the treaty of peace, the annexed territories would be subjected to the duties and taxes of Germany, that is to say, they will be struck with imports equivalent to prohibition. Importation from Switzerland, Belgium, and England would have to fill the enormous void made in the consumption of iron and of fabrics. On the other hand this result would cause to the German producers a considerable disadvantage, because it represents a considerable portion of the total production. This subject forms matter for negotiation, since the two countries would have alike to suffer from the immediate application of the provisions of the treaty. It appears as if there must be established a transition state, granting sufficient delay in order that the material interests of the countries should not suffer.

REPAIR OF WORKS.

The repair of damages caused by the insurrection advances all over Paris; the viaduct of Auteuil is in progress, the restoration of gates, posterns, &c., is being completed, the breaches in the fortifications are mended. Work is going on rapidly at the Palace of Industry, the Exchange, the Richelieu Pavilion of the Tuileries is being supported, as well as the façade of the Théâtre Lyrique. Those parts

of the spiral band of the Vendôme Column which were broken in the fall, have been reproduced on the same patterns as the old ones. The column itself will be re-erected on a new system; in place of being in stone it will be in cast iron, by which there will be secured greater lightness, economy, and rapidity of construction.

MINERAL STEAM HOISTS.

We have lately seen in a mine in the Pas-de-Calais a new type of hoist of great simplicity, and the working of which gives every satisfaction. It is used to lift 6.5 cube yards of coal, which it has to discharge at the mouth of the mines. These mines, compelled in their development to excavate large quantities of rock, produce, besides coal, a considerable amount of stone débris which has to be deposited in the vicinity of the shaft. The spoil banks thus found increase very rapidly, and require the appropriation of ground often very valuable. It is a great object then not to increase the surface works too much, and to give to these banks the greatest possible height; and to effect this the spoil is being lifted about 17 ft. above the top of the shaft. The lifts are composed of a small cage directed by two vertical guides, and intended to receive the coal or other material. The cage is suspended by a chain which is taken round two pulleys suitably arranged, and is attached at the end to a fixed point. The chain passes over a pulley mounted on the piston rod of a vertical steam cylinder. The stroke of the piston is 8 ft. 2½ in., with full admission of steam during the whole stroke. As steam is of course cheap, the arrangement of the apparatus renders its employment advantageous for the particular case in which it is used. This hoist is named after M. Chrétien, the inventor of a system of cranes largely employed.

STEAM FIRE ENGINES.

M. Thirion, maker of pumps in Paris, some time since introduced a system of vertical steam boiler specially adapted for the rapid production of steam, and this he is now using in the construction of steam fire engines. It presents some resemblance to the Field boiler, and the Merryweather engine. It is a vertical cylindrical boiler, and to the roof of the firebox are secured hanging tubes of a U form. These tubes are arranged in a circle, the plane of each U being oblique to the radius of the circle. When the tubes become heated an ascending current establishes itself in the hottest branch, the water descending in the other, and a rapid circulation is effected, which draws all the water in the boiler through the tubes, and which entirely prevents incrustation. This arrangement is somewhat similar to that of the Field boiler, but the inventor thinks that the form of tube he employs is more desirable than that of the straight double tube, because it presents no part likely to retain bubbles of steam, nor to burn under the action of the flame.*

SEWAGE PURIFICATION.

M. Le Chatelier, engineer-in-chief of mines, has just published a memorandum on the purification of sewage water by sulphate of alumina, with its special application to the city of Paris. The author recals the fact that in 1865 he suggested to the municipal administration the use of this reactive agent for the purification of sewage water, and that after laboratory experiments trials on a large scale were made in 1868, near the outfall of the grand collecting sewer, and afterwards continued on a still larger scale in 1869 and 1870 on the other bank of the Seine. The conclusion which the laboratory trials had pointed out had been verified so far as the clarification and disinfection of sewage water was concerned. The water so purified can be kept several days without any decomposition, the deposits dry easily and without any appreciable odour.

M. Le Chatelier desires to see this process applied on a grand scale to the mass of sewage waters of Paris. But the author appears to regard too lightly the success of direct irrigation, tried at the same time as this chemical process. By the former all the fertilising matters of the sewage waters can be utilised without any manifest sanitary inconvenience, whilst the chemical action only draws from the sewage a part of the impurities it holds in solution, and produces, not without considerable expense, a material poor as a fertiliser, and of a practical value so small that it is very difficult to get rid of it. We do not insist upon the point further because this comparison between chemical purification and direct application can be best judged of in England by the practical results produced by them.

RUSSIAN FORTIFICATIONS.—The Russian fortifications at the railway stations of Radziwillow and Wolocysk are being rapidly proceeded with. The former is the last station towards the frontier of the Brest-Berdyczew-Radziwillower Railway. Both stations are of the utmost strategical importance, and have an uninterrupted communication with the Galician nest of railways. In the neighbourhood of Radziwillow Imperial engineers have been engaged for weeks in surveying and levelling, and after their plans a citadel with detatched forts will be erected in the neighbourhood of the station for its further protection. The fortifications are to be completed within three years. A similar course has been adopted at Wolocysk. Other fortifications are already nearly completed, notably in the extension of the works at Lithuanian Brest and Kiew, and their strengthening by detached forts.—*Army and Navy Gazette.*

* [An illustration showing the tubes used by M. Thirion appeared on page 244 of our ninth volume.—ED. E.]

RANDOM NOTES FROM NORTHERN INDIA.

N.W. PROVINCES, July, 1871.

AT this season when the annual migration takes place to the hill stations and the discomforts of the present primitive mode of travelling are brought fully home to all (but particularly to the weary invalids) who seek the cool and invigorating air of the Himalaya ranges, we once more hear the question of light mountain railways revived, and we learn that surveys are actually being made for a pioneer line to the new military sanitarium, Ranechate, up the Kosi valley.

It will no doubt be some time before such railways are seriously taken in hand, but such is the growing importance of the hill stations to India (health and life giving retreats as they are) that sooner or later the necessity for rapid and easy communication between these sanitariums and the plains must force itself on the attention of the authorities and the public. When the engineers come to lay out these lines they may with advantage study some of the present mountain roads in this country, many of which were planned with great skill, and are, although on a small scale, works of no mean importance.

The civil engineer branch of the Public Works Department in Bombay forwarded a memorial to the Secretary of State for India respecting "the disadvantages they laboured under as regards pay, leave, and pension" in 1866, but not having been favoured with a reply they have again submitted a petition. As since 1866 the revised scale of salaries has come into force, they now complain of these disadvantages in the matter of leave and pension only, and they represent that while military officers serving in the Public Works Department have their own liberal rules, civil engineers are under the rules of the rank and file of the uncovenanted service—rules originally framed for a native subordinate service, and which consequently do not provide for the contingency of visits to Europe.

A late number of the Government *Gazette of India* contains the particulars of some most interesting and successful experiments in the cultivation of cotton in the Punjab, made by Mr. Login, C.E., which are in themselves a strong argument in favour of permitting engineers of keen observation to pay periodical visits to other countries.

Mr. Login has lately returned from furlough, and while in Egypt (on his way to India), he gave his attention to the cultivation of cotton in that country, and he is now, by a series of practical experiments of a very successful nature, illustrating the advantages of the new system of cotton cultivation which he proposes to introduce into Northern India, and which it is stated has already produced considerable effect on the minds of the native cultivators. The following is a short account of an experiment made near Delhi:

"No special care was taken with the preparation of the soil; indeed, this was especially avoided. The land which had been under grass for several years was 'scratched' over twice with the ordinary country plough, and after this furrows, 8 in. deep and 3 ft. apart, were made by another native agricultural instrument in common use in the Punjab. After irrigation small holes were made in the ridges at distances of about 2 ft., and several seeds were dropped into each hole. Only the most promising plant springing from the seeds in each hole was allowed to remain, the others were at once weeded out. The cotton was sown on May 29th, and on September 12th many of the plants were over 6 ft. high, covering an area of 15 square feet or more, and in many instances the branches were weighed down to the ground by the weight of the pods. The total yield was at the rate of 307½ lb. of cleaned cotton per acre."

The principle of the system introduced by Mr. Login is to have each plant separate and to place them sufficiently far apart to allow space for the admission of a sufficiency of air and light. Irrigation also is necessary.

It is surprising how little attention the subject of the improvement in agriculture in this, a purely agricultural country, has received up to the present, but it is to be hoped that a new era will open under the auspices of the agricultural department, a department which has a wide field for usefulness before it, and which, if properly conducted, must do much and lasting good for the natives of India.

An experimental trip was lately made on the Punjab Railway for the purpose of ascertaining the effect of Saunder's patent, and the "cowl" arrangement for cooling railway carriages. In an ordinary first-class carriage the heat was 89°. In the *tattie* carriage, with the cowl, the thermometer varied from 72° to 82°, and the coolness was said to be very pleasant, while in a carriage fitted up with Saunder's patent, the thermometer varied from 82° to as low as 66°, which latter was pronounced to be *too cold*. These and other experiments are the result of Lord Mayo's able minute, called forth first by the large number of deaths in railway carriages, from heat apoplexy, which took place last May and June, and by the apparent indifference to these numerous casualties shown by the Indian railway companies.

It has been announced in several papers that Mr. Hugh Leonard, civil engineer, is to succeed Colonel Nicolls, R.E., as chief engineer of Bengal, and if the report be true (which there is little reason to doubt), the fact of this appointment, which is one of the highest prizes in the service, having been given to a civil engineer, will give great satisfaction to the other members of the profession in the P.W.D., and it will have a good effect on the service generally.

Major Laughton, revenue survey superintendent, has introduced a new surveying instrument, which, if his description of its merits can be relied on as not being oversanguine, promises to be a very useful addition to the surveying instruments at present used by the engineer, if, indeed, it does not supersede most of them. He calls it the omnimeter, and says of it: "It is useful for city surveying, in laying down traverse lines; all chaining is done away with, horizontal angles are taken at one and the same operation; for surveying and levelling in rough, hilly, and thickly-wooded country. Only those who have been obliged to use theodolites and chains in such places can understand what a boon this instrument will be to others similarly employed. For railway and irrigation purposes it is equally, if not more useful."

From Simla (the hot-weather retreat of the Government) and other hill stations the usual annual cry of scarcity of water is again heard, but, although that want is sadly felt each year before the setting in of the rains, and the facilities for storing abundant supplies of water are numerous in the hills, yet no active steps are taken. Hill station communities, like those of your watering places at home, are constantly moving and changing, and take but little interest in the welfare and improvement of these pretty and cool summer retreats.

The appointment of Mr. Molesworth, C.E., to the office of inspector-general of the State railways for India has taken by surprise many who watched with astonishment some of the appointments which were first made in that department, as it shows that the necessity for engaging the services of men of sound practical railway experience is beginning to force itself on the Government of this country.

NOTES FROM THE SOUTH-WEST.

The Narrow Gauge at Briton Ferry.—The narrow gauge is to be carried to Briton Ferry. The change will not, however, be completed before June, 1872.

A Clock Bell for Lord Bute.—A large clock bell has been placed in the new tower at Cardiff Castle. It has been constructed by Messrs. Dent, of London, and is precisely similar to the one in the Victoria tower of the new Houses of Parliament except that it is only half the size.

Rhymney Railway.—The works on the Penallian branch and on the northern line of the Rhymney Railway Company are now completed and will be inspected by the Board of Trade in a few days. The Cardiff and Caerphilly line was made available for traffic April 1 and has since worked satisfactorily.

Trade at Cardiff.—A fair business is being done at the iron works in the neighbourhood of Cardiff. The quantity of coal brought down from the collieries is increasing, and it is hoped that in a few days matters will regain their old activity.

Bristol Water Works.—The directors of the Bristol Water Works Company have decided to extend the company's mains to Westbury-on-Trym, for the accommodation of the increasing population of that village and the neighbourhood.

Llynvi and Ogmore Railway.—At the half-yearly meeting of the shareholders in this undertaking, the chairman stated that the traffic prospects of the line were favourable. Several new furnaces along the line had been opened and put in blast.

Welsh Shipping Movements.—The Coquet has cleared from Cardiff for Trieste with 1400 tons of railway iron supplied by the Dowlais Iron Company. The Water Lily has cleared from Cardiff for Naples with 220 tons of bar iron supplied by Messrs. J. Bovey and Co. The Cherokee has cleared from Cardiff for Montreal with 766 tons of railway iron supplied by Mr. R. Crawshay. The Sator has cleared from Cardiff for New York with 850 tons of railway iron supplied by the Dowlais Iron Company. The Agra has cleared from Cardiff for Boston, U.S., with 800 tons of railway iron supplied by the Aberdare Iron Company. The Morsea Minor has cleared from Newport for New York with 510 tons of iron supplied by Messrs. Bailey Brothers and Co. The Castalie has cleared from Cardiff for New York with 470 tons of bar iron supplied by the Aberdare Iron Company. The Mazatlon has cleared from Newport for Vera Cruz with 410 tons of iron supplied by the Ebbw Vale Iron Company. The Ann has cleared from Newport for Rio de Janeiro with 350 tons of iron supplied by the Ebbw Vale Company. The Glory of the Seas has cleared from Cardiff for San Francisco with 1000 tons of railway iron supplied by the Dowlais Iron Company, and 500 tons of railway iron supplied by the Aberdare Iron Company. The Lunefield screw steamer has cleared from Cardiff for Trieste with 1700 tons of railway iron supplied by the Rhymney Iron Company. The Tamaya has cleared from Cardiff for Talcahuano with 553 tons of railway iron, 150 tons of corrugated iron, 85 tons of fish-plates, and 19 tons of spikes and bolts supplied by the Rhymney Iron Company.

Great Western Colliery Company (Limited).—This company sold during the past year 91,917 tons of coal, against 87,326 tons in the previous twelve months. The profit realised last year was 4332*l*.

Cornwall Railway.—During the past half-year the Cornwall Railway Company expended a further sum of 1022*l*. in the conversion of the Probus viaduct into an embankment. The work was completed in July.

Settlement of Strikes.—The terms of an agreement have been approved for referring the matters in dispute between the steam coal owners and the colliers of South Wales to arbitration. Pending the arbitrators' award, the men will resume work upon payment of draws on account, calculated according to prices paid in May last. A further strike of miners in the Forest of Dean has been averted by an amicable settlement of differences.

Devon and Cornwall Railway.—The Devon and Cornwall Railway Company's line will be opened to Okehampton on Tuesday. There will be appropriate festivities on the occasion.

South Wales and West of England Coal and Metal Markets.—A market, which was held at Swansea on Saturday, was rather thinly attended, and few transactions were reported. The iron and tinplate trades continue, however, in a healthy state, and prices are well maintained. Iron ores are much sought after, and command high prices.

Swansea Vale Railway.—The contractor upon the Swansea Vale Railway Company's branch at Morriston has so far completed the works to Morriston that notice has been forwarded to the Board of Trade to the effect that the line is ready for inspection prior to being opened for passenger traffic. The directors have let a contract for the remaining portion of the branch to Clydach and Glais, which will complete all the works proposed to be executed by the company.

Plymouth Great Western Docks.—The South Devon Railway Company holds 9770*l.* of 5 per cent. preference shares in the Plymouth Great Western Dock Company. This stock was allotted in settlement of claims for arrears of interest. The improving condition of the dock company has resulted in an increasing rate of dividend on the shares in question, now amounting to 3 per cent.

Mundy Iron Ore Company.—A meeting of this company was held on Monday at No. 6, Queen-street-place, Upper Thames-street, London. The chairman of the company (Mr. A. Brogden, M.P.) presided. The report presented by the directors was of a satisfactory character upon the whole, and an interim dividend was declared.

Great Western Railway.—The ordinary stock of this undertaking has once more touched par. In August, 1845, it stood at 156 premium; in the spring of 1867 it was at 60 discount. For several years the dividends received upon the stock were at the rate of 8 or 10 per cent.; in 1858 they came down to *nil*. Wonderful have been the ups and downs of the Great Western.

Gloucester Wagon Company.—This company yields its proprietors 9 per cent. upon their shares for the year ending June 30, 1871. The directors complain, however, that the reckless competition of other companies, some of which pay no dividends at all, has had the effect of reducing, not only the manufacturing profits of the undertaking, but also the percentage of wagon rents. The carriage and wagon stock belonging to the company now consists of 10,454 vehicles, viz., 10,358 wagons, and 96 carriages and brake vans. During the last twelve months 1183 wagons were built by the company.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—There is a large and rapidly-increasing business being done in iron, the demand for which just now appears to have no limit, and the upward tendency in prices is generally maintained. The warrant market is irresponsible, and goes on improving, although fluctuations may, and do, take place. From the Continent there is still an increasing demand for Scotch iron, and, notwithstanding the present high price of pigs here, it still pays to ship them to America. The following were the prices of Scotch special brands at the end of last week, but since then they have risen about 1s. per ton all round: Gartsherrie No. 1, 72s. 6d., No. 3, 62s. 6d.; Coltness No. 1, 72s. 6d., No. 3, 62s. 6d.; Summerlee No. 1, 69s., No. 3, 62s.—*f. o. b.* at Glasgow; Langloan No. 1, 68s., No. 3, 63s., No. 4, 62s., 6d. extra at Glasgow; Calder No. 1, 67s., No. 3, 62s., 1s. extra at Glasgow; Shotts and Castlehill No. 1, 66d., No. 3, 61s., No. 4, 64s. *f. o. b.* at Glasgow; Carnbroe No. 1, 64s., No. 3, 61s. 6d., 6d. extra at Glasgow; Monkland No. 1, 63s., No. 3, 62s., ditto Chapelhall No. 1, 63s.; Clyde No. 1, 62s. 6d., No. 3, 61s. 6d., Quarter No. 1, 62s. 6d., No. 3, 61s. 6d.—*f. o. b.* at Glasgow; Eglinton brands No. 1, 62s., No. 3, 61s., No. 4, 61s. 6d.; Dalmellington No. 1, 61s. 6d., No. 3, 60s. 6d.; Ardeer and Glengarnock No. 1, 66s., No. 3, 61s.—*f. o. b.* at Ardrossan; Kinneil No. 1, 63s., No. 3, 58s., No. 4, 57s.; Almond No. 1, 62s. 6d., No. 3, 58s., No. 4, 57s.; Lochgelly No. 1, 62s. 6d., No. 3, 58s., No. 4, 56s.; Gladsmuir, No. 1, 62s. 6d., No. 3, 59s., No. 4, 58s.; Lumphinnans No. 1, 59s., No. 3, 57s. No. 4, 57s.; Bridgeness No. 1, 61s., No. 3, 57s. 6d., No. 4, 56s.—*f. o. b.* on the Forth. The prices on Wednesday last varied between 63s. 1½d. and 61s. 10½d. cash, and 62s. 5½d. and 62s. 3d. one month. On the following day the cash price was down at 61s. 9d., and the month's price at 62s. 1½d.; on Friday there was an improvement, and in the afternoon the market was especially strong. A very marked advance took place on Monday, the market closing buyers at 63s. cash, and 63s. 4d. one month; and there was a slight further advance yesterday. The market has been very strong to-day, 63s. to 63s. 6d. cash, and 63s. 9d. to 63s. 10d. one month.

Advance of Wages in the Iron Trade.—A number of blast furnaces were damped down last week on account of a demand being received from the furnacemen for an advance of 1d. per ton. The matter in dispute has been compromised by the employers offering and the men accepting an advance of ½d. per ton. This advance has become very general throughout the Scotch iron districts, and the works are going on as usual. An advance has also been given in the finished iron department. It is equal to 6d. per ton on puddlers' prices, and 5 per cent. on millmen's. What makes this advance specially worthy of mention is the fact that it was granted without any request being made or any appearance of a strike. It is not strange, under these circumstances, to learn that the quoted prices for finished iron have been advanced 10s. per ton in some instances, and less amounts in others.

Contract for a Great Ocean Liner.—Messrs. Caird and Company, Greenock, have been instructed by Messrs. Inman to build for their Liverpool and American line a screw steamer of about 480 ft. over all, and about 430 ft. keel and fore rake, 44 ft. breadth of beam, 36 ft. depth of hold, while the gross tonnage of the ship will be about 4800 tons. The vessel is to be supplied with the builders' compound engines of 750 horse power. She will be full ship-rigged, and it is expected that she will attain a speed of 16 knots an hour. The steamer will be the largest merchant vessel afloat, excepting the Great Eastern, the latter being about 130 ft. longer than the proposed new steamer. Messrs. Caird, it is stated, have been exclusively selected by the Inman Company to build this vessel, and as *carte blanche* has been given the builders to produce one of the best ships possible, it is anticipated that the steamer will command considerable attention.

The New City of London Steamer.—This new steamer, the property of the Aberdeen and London Steam Navigation Company, was launched from the yard of Messrs. John Elder and Co. a few weeks ago, and on Saturday week she arrived in Aberdeen to commence her trade on Saturday last. The old City used to take 46 hours on the voyage between Aberdeen and London, but the new vessel will accomplish the voyage in 36 hours, a tide less, and effect a saving of upwards of a hundred tons of coal on each double voyage. She accomplished the distance between Greenock and Aberdeen—554 miles—in 39 hours, being an average speed of 14 miles an hour, the performance of her engines being most satisfactory. The contract speed was 13 knots an hour. The new City of London is of the following dimensions: Length, 241 9-10ths ft.; breadth, 30 5-10ths; depth of hold, 16 7-10ths; and tonnage, 977 tons. Her engines are 275 horse power nominal, and over 1300 of actual power. She has 70 berths for first-class and 50 berths for second-class passengers, and stalls for 170 head of cattle.

A Novel Idea in the Construction of the Tay Bridge.—In accordance with a suggestion made by Mr. Yeaman, Provost of Dundee, it is intended to make cast-iron pipes of 2½ in. in diameter do service as part of the railing of the Tay Bridge, so as to convey water and gas from Dundee into Fifeshire. But how about freezing the water in winter?

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday on 'Change at Middlesborough there was an excellent attendance. The market was firm and closed at the following rates: No. 1, 54s.; No. 2, 52s. 6d.; No. 3, 50s.; and No. 4, 48s. 6d. Again there was such a demand for pig iron for shipment that a premium of 6d. per ton was offered for pigs to load steamers waiting to complete their cargoes in the Tees. Even the premium failed to procure the desired quantities. Certainly the pig-iron trade of Cleveland was never in a sounder condition than it is at present. Good prices are being obtained, makers are producing upwards of 158,000 tons per month, and their order books are full. To assist in the deliveries stocks are reduced to a minimum, and the warrant stores at Middlesbrough have under the pressure for iron diminished to about 6000 tons.

The Finished Iron Trade.—All the branches of the finished iron trade are in a satisfactory condition. Inquiries for rails as might be expected owing to the season advancing are not so numerous, but the number of contracts placed at the various works in Cleveland and on the banks of the Tees, Wear, and Tyne are sufficiently heavy to keep the mills going for months to come. Owing to the prosperous state of the iron shipbuilding trade in the north there is an excellent demand for plates and angle iron. Bars, sheets, rods, and billets are in request.

The Cleveland Water Company.—The half-yearly meeting of this company was held at Saltburn on Monday. A dividend of 5 per cent. per annum was declared. The report stated that the company's pipes had been extended to Upper Marske, and by a further extension of half a mile a connexion could be made with the pipes of the Redcar Local Board of Health whenever their source of supply was drained by the Upleatham ironstone workings. The district supplied by the Cleveland Company includes Saltburn, Skelton, Brothen, and Upper Marske, and the companies are engaged in extending the pipes to Marske. The report was adopted. It was stated by the chairman that the new reservoir at Lockwood Beck Bridge would cover about 42 acres. It was resolved to raise the sum of 18,000*l.* under the powers of the Cleveland Water Works Act for constructing a reservoir at Lockwood Beck by issuing 1800 new ordinary shares of 10*l.* each.

Engineering.—Throughout the North of England the engineering trade is as brisk as possible. A large number of locomotives are being constructed at Messrs. Stephenson and Co.'s works, Newcastle, which have not been affected by the disastrous strike for the nine hours' movement. The marine engine builders find their order books as full as ever. No sooner do they complete one pair of engines than they discover that while they have been busy with those, orders for four or five more have been accepted. General engineering is in a healthy condition, owing to the extension of manufactories on the banks of the northern rivers.

The Nine Hours' Movement.—The best quarter of the year 1871 has glided by, and the places of nearly 9000 men in the engineering establishments at Newcastle-on-Tyne have been vacant on account of the lamentable strike for the adoption of the nine hours' movement. Week after week we have briefly recorded the events connected with this suicidal war. Once more, we regret to say, there is no prospect of a termination of the strike. Last week we mentioned the fact that there had been a meeting of capitalists in London, who had resolved to share the expense in importing 2000 foreigners for the purpose of working in the factories of Newcastle. Already a number of Belgians have arrived, and taken places under the several firms, and others are expected soon. Nothing approaching the number required have put in an appearance yet, and it is believed that the arrival of batches will not be so prompt as was expected, on account of the representatives of the men on the Continent agitating for an advance of wages there, and informing the operatives of the fact that there is a gigantic strike at Newcastle for the reduction of the hours of labour. The number of men on strike in Newcastle is still diminishing by men who have obtained work in other towns, leaving Tyneside. The number remaining is now only 2978, and this week it is stated that the Nine Hours' League will be able to pay them 6s. per man, and 1s. per child extra. Since the result of the meeting of capitalists in London was made known, the delegates of the men have been more active in arranging meetings throughout the country, sympathy has extended, and subscriptions have increased. The men are as sanguine as ever that the nine hours' system will be adopted. They look upon the scheme of importing foreigners as impracticable, and predict that the masters will speedily be as anxious to get the Belgians back to their own country as they were to bring them to England.

ENGLISH STEAM FIRE ENGINES IN AMERICA.

WE notice the following in the *Montreal Gazette*, of the 1st instant: "Yesterday afternoon, the steam fire engine purchased from Messrs. Shand, Mason, and Co., London, England, by the corporation, for use in case of fire in any of the houses occupying elevated positions about Sherbrooke-street, where there is too slight a pressure of water from the reservoir to be of service, was tested in the Place d'Armes-square. The members of the fire committee, members of the City Council in town, and the Mayor of St. John's, were present. The event was the source of much attraction, so long is it since an engine of any kind has been seen in the city, their services not being required since the establishment of the present system of waterworks. The engine, which is one of Messrs. Shand, Mason, and Co.'s second-class small engines, was placed at the basin of the fountain, which was filled with water, and suction taken from it. The basin was kept well filled from a neighbouring hydrant. Two lines of hose were laid from the engine—one to St. Sulpice-street, and the other to the base of one of the towers of the French church. The members of the fire brigade were in charge of the branches, and the engine was under the superintendence of Mr. Stabler, the gentleman who came with it from England. The gates of the square being closed, the fire was lighted in the furnace, and the following was the correct time taken in getting up steam from the time the smoke first appeared through the smoke stack:

5 lb.	...	...	3	minutes	50	seconds.
10	,, ...	...	4	,,	15	,,
15	,, ...	...	4	,,	40	,,
20	,, ...	...	5	,,	0	,,
30	,, ...	...	5	,,	30	,,
40	,, ...	...	5	,,	55	,,
50	,, ...	...	5	,,	50	,,
60	,, ...	...	5	,,	55	,,
65	,, ...	...	6	,,	5	,,
70	,, ...	...	6	,,	10	,,
100	,, ...	...	6	,,	35	,,

Water was playing from the nozzle in 6 minutes 45 seconds. From one ⅞ in. nozzle a stream was thrown on the western tower of the French church to a height of 170 ft., touching the lower ledges of the window above the clock chambers. A horizontal stream was then thrown 190 ft. through an inch and a quarter nozzle. A large tank of 300 gallons capacity was then placed near the square, and this was filled in 40 seconds, being equal to throwing 450 gallons of water per minute. The greatest steam pressure at any time was 165 lb., and the average water pressure was 140 lb. Several other tests were then made, all of which were very satisfactory, and at their conclusion the fire committee expressed themselves very well satisfied with the trials made. The engine, with the highest pressure of steam on, worked without a single vibration. Although only one of the smallest manufacture of Messrs. Shand, Mason, and Co., it will be seen, by comparing the following time taken in getting up steam at the trial of the first-class Silsby engine, lately, in Toronto, that the engine tested yesterday completely put the large American one in the shade as regarded the rapidity with which the steam was generated:

5 lb.	...	...	2	minutes	30	seconds.
10	,, ...	...	4	,,	45	,,
15	,, ...	...	5	,,	30	,,
20	,, ...	...	6	,,	30	,,

It will be thus seen that while the Silsby engine took 6 minutes 30 seconds to get up 20 lb. of steam, the London engine in that time had 100 lb. of steam, and threw water one minute and a half sooner than the American engine. The whole weight of the engine, with everything ready to go to work, and carrying its own hose, is 400 lb. The test of the engine was in every particular satisfactory."

FOREIGN AND COLONIAL NOTES.

The Wardah Coal Field.—Designs and estimates for the Wardah and Wurrora Coal Field Railway have received the preliminary sanction of the Government of India. Working operations are expected to be commenced in October. The line is 50 miles in length and will involve the construction of several important works such as the Wunna, the Potra, and the Ambea river bridges.

Railways in Turkey.—It is stated that the Turkish authorities have determined to proceed at once without any aid from foreign capitalists with a line from Soutari to Ismidt. The section is regarded as the *tête de ligne* of a great projected railway from Constantinople to Bussorah; and it is expected that when a commencement is made with this important work foreign capitalists will be encouraged to join in and complete the undertaking.

Victorian Water Works.—The post of resident engineer to the Victorian Water Supply department has become vacant through the death of Mr. Clement Wilks. It is not expected, however, that any appointment will be made until Colonel Sankey, who has been inspecting the works, has sent in his report to the head of the department.

Northern Railway of Queensland.—In connexion with this line it may be noted that a working survey has been completed to the Dawson. Beyond the Dawson there is only a feature survey to a point north of Expedition Range. The completed portion of the line from Rockhampton to Westwood is 30 miles in length. The revised surveyed line from Westwood to the Dawson will be rather more than 29 miles long.

Russian Railways.—Smolensk advices state that trains have already run along 217 miles of the newly completed line between that town and Brest-Litovsk. The line is expected to be opened for traffic about the middle of next month, and, when ready for the circulation of trains, it will complete direct communication between Moscow and Warsaw. Another line, in course of construction between Brest-Litovsk and Kiew, has not at present made any very great progress.

The United States Navy.—Mr. J. K. King, chief engineer of the United States Navy, who was sent to Europe recently on a mission connected with his department at Washington, is at present in Paris. Since his arrival on this side of the Atlantic, Mr. King has visited Sheffield, London, and various Continental cities. Commodore Rodgers, of the United States Navy, is also in Europe on a professional visit.

American Steam Navigation.—Captain Roberts, of San Francisco, representing the Webb-Holladay line of New Zealand and Australian steamers, has recently visited Victoria, Vancouver's Island. The object of his visit was to conclude a contract with the Vancouver Coal Company for the supply of the steamers with several thousand tons of coal to be delivered at Honolulu, Sandwich Islands.

Western Australian Timber Company.—The works of this company are steadily approaching completion. The object is to develop the timber trade in the Vasse district. An engine of 90 horse power, to work a large sawmill, has been erected, and the nucleus of an active little township has been formed. The district which the company has selected as its field of operations may be said, indeed, to resound with the woodman's axe, the cry of bullock drivers, and the general hum of industry.

Midland Railway of Canada.—This undertaking has passed into the hands of an Anglo-Canadian Company, of which Mr. Hugh Allan is the head. The new company is about to immediately commence works for the extension of the existing lines from Beaverton to Georgian Bay.

Atlantic and Great Western Railway.—The Ohio portion of this railway has been sold to Senator Tharman, General Mc Clellan, and Mr. W. B. Duncan, trustees, for 4,435,500 dols. There were no other bids.

Fuel in Russia.—Various experiments have recently been tried in Russia both by land and sea in order to test the comparative excellence of different kinds of fuel. Turf has been found a good substitute for firewood upon some of the northern railways; and recent trials of naphtha, in place of coal as fuel for steamers upon the Black Sea, are stated to have been successful.

DANKS'S PUDDLING FURNACE.

A FEW months ago we gave some particulars in this journal (*vide* page 380 of our last volume) of a form of rotary puddling furnace which has of late been attracting considerable attention in the United States, and of one form of this furnace, which has been designed by Mr. Samuel Danks, of Cincinnati, Ohio, we now publish engravings. Referring to the latter, it will be seen that the working part of the furnace consists of a cylindrical chamber, A, having a refractory lining, and so mounted on a series of rollers, B, that it can be caused to revolve by suitable gearing. As in case of the rotary puddling furnace tried some years ago by Mr. Menelaus, at Dowlais, one of the principal difficulties which Mr. Danks had to overcome, was the procuring of a suitable material for lining this cylinder. This difficulty, we hear, has been surmounted by the employment of a kind of ore found in Missouri; but we have as yet seen no analysis of this ore, nor have we received any detailed particulars of the manner in which it is fixed in place. These important points will, however, we trust, be fully explained in the paper on this furnace, which is to be read next week before the Iron and Steel Institute.

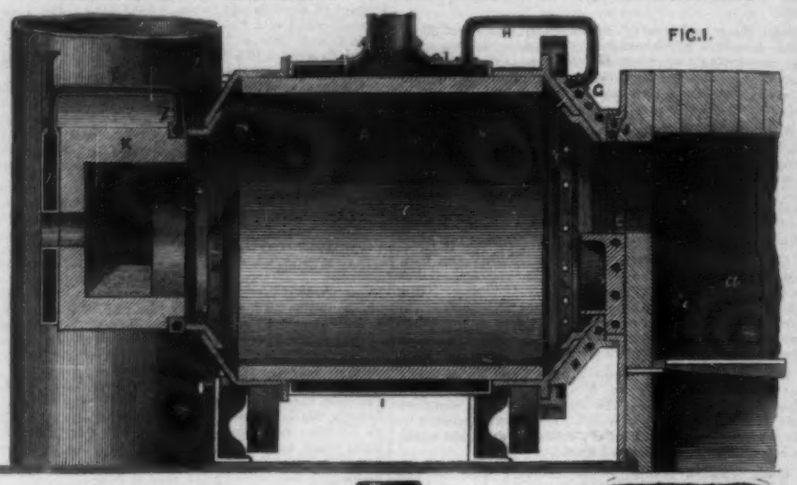
Referring again to the engravings, it will be seen that the chamber, A, is contracted in diameter at the ends, one end being in communication with the chamber, *a*, in which the fire is situated, while the other end is open to the chimney. One important feature in the furnace is the provision made for cooling the parts most exposed to the heat. Thus the bridge, C, has encased within it a coil of pipes, D, for the conveyance of water, steam, air, or other cooling fluid. The first return of the coil of pipes, D, is carried through the arch over the passage from the grate to the refining chamber, as shown in Fig. 1. This pipe is connected with the spiral pipe, F, encased in the annular water collar, G, which is secured to the bridge end of the grate, *a*, or about the hot-air passage, of which the bridge, C, forms the lower edge or face. The conically concave face of the annular collar is of a form adapting it to fit closely the surface of the end of the refining chamber. A discharge pipe, H, is connected with the last return of the spiral pipe, F, in the annular collar, G, and terminates at an opening in or near the top of the water casing, I, which is constructed of thin metal, having its edges turned in toward the refining chamber, which it entirely surrounds, without being in immediate contact with it. The mouth of the movable piece, K, which is in immediate contact with the end of the refining chamber, A, furthest removed from the grate, is constructed with an annular pipe, *k*, the cooling fluid being supplied to it through the feed pipe, *k'*. The inner conical faces of the ends of the refining chamber, A, are covered with the annular metal facings, L, secured in place by bolts or screws. The outside face of the movable piece, K, is protected from the heat by the water chamber, *k*.

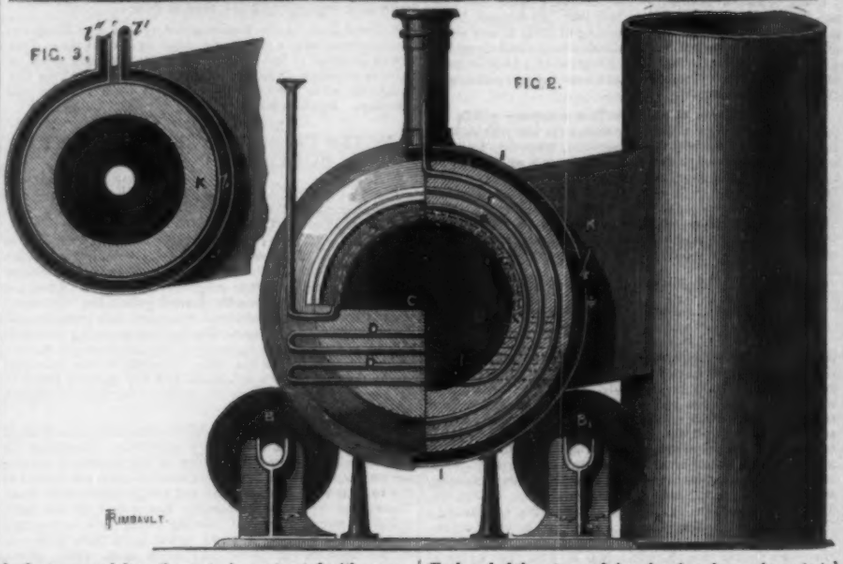
The edges and faces of the opening from the grate to the rotary refining chamber over the bridge, C, and also the ends of the chamber, A, and movable section of the smoke flue are the parts of the puddling furnace subjected to the more intense heat, and consequently are quickly destroyed. To prevent the rapid destruction of these parts of the furnace, Mr. Danks places in close proximity with them a series of pipes or confined channels for the conveyance of water which flows freely or may be forced to circulate through these ducts so that a low temperature may be insured. The current of cooling fluid having passed through the coil in the bridge, C, is conveyed by the pipe, J, over the opening from the grate, *a*, to the chamber, A, into the spiral pipe, F, in the annular collar, G, reducing the temperature of the parts by and through which it passes, and is emptied from the discharge pipe, H, upon the top of the rotary refining chamber, A, over the surface of which it spreads, diminishing its temperature. Finally, the steam evolved from the water in its passage through the pipes escapes under the edges of the casing, I, and the fluid part sinking to the lowest part of the casing, I, overflows its edges and escapes into a suitable receptacle. Water or air is introduced into the chamber, *k*, which is constructed upon the outer face of the movable piece, K, furthest removed from the grate, thence it is conducted by the pipe, *l'*, into the annular pipe or chamber, *l*, located in one edge of the movable piece, K, and in contact with the metallic ring, L, or, in the absence of the latter, with the edge of the refining chamber, A. The water is carried off after its passage through the ring, *l*, by the waste pipe, *l''*, and discharged into the chamber between the casing, I, and the rotary refining chamber, A. The facings, L, are attached in a secure manner either to the interior conical ends of the refining chamber, A, or to the exterior of the latter by bolts or screws. The facings may for convenience in handling be constructed in sections. They serve as an additional protection to the ends of the refining chamber, A. Each end of the rotary refining chamber, A, may be protected by an annular collar, G, from the action of the heat.

The action of the furnace is very simple, but we may describe it briefly. The charge is inserted at the chimney end and as it melts the revolving chamber, A, is set in motion, and the iron is carried up and rolls down the inclined sides. As it becomes more and more fluid it is carried up further and further until at last it comes dripping down, from the top through the hottest part of the furnace thus exposing the metal thoroughly to the action of the heated gases. The workman's part in the matter is confined to watching operations and inserting and removing the charges. The latter are very large, it being found most profitable to work 10 cwt. at a heat and to let the furnace make this up into a single ball. We are informed that at the mill where the invention was first introduced all rails are now made direct from the bloom without cutting or piling at all; but we cannot say that we have much faith in such a mode of manufacture.

The first experiments with Mr. Danks's furnace were made at the Cincinnati Railway Iron Works in May, 1868, with a small furnace constructed to puddle from 250 to 300 lb. per heat. In April, 1869, two larger furnaces were erected at the same works, and these, we understand, are still in use. In February, 1870, also the same company decided on the substitution of Mr. Danks's furnaces for all their hand puddling furnaces and the latter, we hear, have now been quite done away with at these works. Other furnaces also, have been erected during the past year for the Indianapolis Rolling Mill Company, and for the Albany Mill Company, while furnaces are in progress at other places. Of the results of working with this furnace we do not intend to speak here, as the latest data on the subject will no doubt be given in the paper to be read next week before the Iron and Steel Institute, and which we hope to be able to publish in an early number. We trust that Mr. Danks may get a trial of his furnace in this country, and we shall be glad to know whether we possess any substance readily available which will serve as a substitute for the Missouri ore said to be used for lining these furnaces on the other side of the Atlantic. At present we cannot say that the information at our disposal concerning Mr. Danks's furnace is sufficiently detailed to enable us to form any definite opinion as to its applicability in this country; but we wish it every success.

DANKS'S ROTARY PUDDLING FURNACE.





RAILWAY GAUGES.*

By R. F. FAIRLIE.

(Concluded from page 102.)

In the report of the Royal Railways' Commission, published in 1867, the following pregnant conclusions were arrived at from the opinions of the principal engineers and railway managers in this country: "The only way in which an increased receipt in proportion to the cost of running the trains can be anticipated, is in carrying a larger number of passengers in proportion to the number of passenger carriages in the train, and running the goods' trucks full instead of partially full; or, in other words, obtaining a greater amount of work out of the engines and carriages than at present. But this means that the passenger trains would be less frequent and more crowded; that the passengers going on to branch lines would have to change carriages more frequently; and that goods would have to be retained until full truck-loads were made up, which would result in a slower delivery of goods."

So that, as the necessities of traffic enforce frequent passenger trains, three or four times the necessary weight of carriages must be provided, and as goods cannot be detained until trucks are fully loaded, it follows that universal extravagance is inseparable from the present system. Railway managers, who are of course thoroughly conversant with the subject, agree that our existing railways are at present being worked to the best advantage. If so, it cannot be doubted that there is a grave blunder somewhere; and if this blunder is not to be discovered in management we must seek for it in construction, and there we shall find it. We shall find that railways of the existing gauge will labour under disadvantages for all time; they will remain oppressed by the curse of dead weight, an evil from which they can by no means be relieved; dead weight in their rolling stock for passengers, one ton of which requires thirty tons to convey it; dead weight in their rolling stock for freight, which can never be more than one quarter fully loaded, and dead weight in their locomotives, ill applied for obtaining useful results but always destructive to the permanent way.

Nor does increase of traffic upon a great standard railway system tend to reduce this evil; if it did, the London and North-Western Railway would not at the present time be expending enormous sums in doubling their permanent way. Experience shows that increased traffic does not diminish averages of weight; for the fact that these averages were larger twenty years ago than they are at present, although the traffic had not then reached half its present dimensions, was simply because the wagons then averaged about a ton less in weight. With a doubled business, each wagon does not carry twice the average amount that it carried twenty years ago; but twice the number of wagons then employed carry each their usual complement of a single ton. There is, therefore, no escape from the conclusion that the existing proportion of dead weight to paying weight upon a 4 ft. 8½ in. railway cannot be reduced so long as the condition of things exists which guided the Railway Commission to its conclusions, but that it must remain a fixed quantity independent of increase of business on the line.

I think no more striking illustration of the error of our present system can be conceived than is afforded by the daily practice of a magnificent company like the London and North-Western Railway, who, at the present moment, be it remembered, have commenced to double the width of their road through press of business; yet who are sending out daily, and daily receiving, at Euston-square, some 4400 passengers, in carriages which contain sitting accommodation for 13,500; and who carry their enormous freight in increments, averaging less than 1 ton, in wagons having six times that capacity. Imagine the amount of capital sunk before this result was obtained! Conceive the waste of engine power, the wear and tear of rolling stock, the destruction of permanent way, the cost of staff, all entailed by this curse of dead weight; and then imagine how easily all this unmechanical and unbusiness-like state of affairs might have been prevented by the simple adoption of a suitable rolling stock running on a suitable gauge! I am not for a moment advocating any radical change in our English railway system; that system has outgrown the season of radical reform, and we must make the best of it as it is; but I seek to prevent the repetition elsewhere of mistakes that have been so costly here. I want to prevent the unnecessary extension of a system that is palpably false, but which is not on that account the less strongly defended and protected.

That our great error was known some years since to all thinking engineers is shown by the quotation I just now made. Mr. G. P. Bidder stated before the Royal Commission "that great economy may yet be obtained in the transport of minerals over long distances by means of railways laid out under conditions admitting of very long trains being run." In this statement I find the very essence of the question at issue between myself and all conservative engineers; I find the necessity for reform acknowledged. Except that his views did not extend to passengers and goods, but were confined simply to the transport of mineral traffic, we have a complete statement of the problem which I have brought successfully to a solution. The requirements which Mr. Bidder hinted at generally, I have worked out in detail, and have extensively reduced to practice, with results that show his judgment to have been sound as far as it went. The conditions under which a railway should be laid out to meet these requirements are clearly not those which rule the present system; ample experience proves the contrary, showing that no line, however full of business, can be worked to its full capacity. We are led, then, unmistakably, to a narrow gauge, to the adoption of passenger carriages which shall be filled, of wagons which shall be almost fully loaded, and of weight which shall bear a reasonable proportion to their capacity, and we are led to the adoption of very long trains and powerful engines. Considering the date of Mr. Bidder's opinions, they could not have been put more clearly or more concisely.

To a certain extent, but in a very limited and imperfect degree, experiments were made in the direction indicated—faint foreshadowings of the practice now being so widely introduced—by an attempt to convey extremely heavy trains by means of an auxiliary pair of cylinders placed under the tender of the engine and receiving steam from the boiler; the idea being to utilise all the available weight of engine and tender for adhesion. In running expenses, the results of these trials were very satisfactory, showing a large reduction of cost in carrying the heavier load. There were many reasons why this absurd arrangement should prove unsatisfactory, but I quote the results obtained, because they will not be called in question, and because, if so much economy could be obtained by such a contrivance as the steam tender, I may at least claim proportionately advantageous results for the system of which this was an indication.

Thus, with an ordinary engine, the cost of conveying a load of 210 tons was 20d. per mile, whilst the cost of conveying a load of 310 tons by the aid of the steam tender was only 23d. per mile. It is obvious that no such saving as this could have been effected had two independent engines been employed upon the same duty. The results clearly prove that a large saving can be effected by increased engine power and greater loads; but, as I have already pointed out, this economy cannot be realised on railways of the standard gauge: but on the many thousand miles of narrow-gauge railways that will before many years be constructed, the true system of economical working, developed by me, will not only be possible, but will be universally acknowledged and adopted.

It would seem a very simple and self-evident fact that the means of conveyance should be fairly proportioned to the amount to be conveyed, and yet I have been labouring for years to make people understand this. One would think it would be sufficient to point out, to countries contemplating the construction or the great extension of railways, and looking to England and English practice as a model, that the best labours of our engineers, after thirty years' experience, have given us a railway system on which it is necessary to have 4 tons of wagon for every ton of goods, and from 10 to 30 tons of carriages (see the diagram) for every ton of passengers. And indeed abroad it is pretty widely understood that it can only be on a narrow-gauge railway that a full measure of usefulness can be obtained, and a proper proportion between paying and non-paying load can be secured; and this is because the amount of engine power being unlimited, better paying trains can be carried on the narrow than on the broad gauge; the difference arising from the fact that the dead weight required for the transport of passengers and goods is reduced in the manner shown by practice and indicated in the diagram. The reform is effected by the adoption of a suitable rolling stock, in which dead weight is kept down by the smallness of the gauge, but in which ample capacity is obtained. Such carriages and wagons exactly meet the difficulty which is one of the great causes of dead weight on a 4 ft. 8½ in. gauge—namely, the necessity of transmitting passengers and goods, whenever practicable, to their destination without change of vehicles. With the small carriages and wagons, the expense attending this proceeding is reduced to the lowest possible cost, because, though vehicles of appropriate capacity can be employed, and each can be loaded almost to its full complement of passengers or goods, carriages half or two-thirds empty would never form necessary accompaniments to a train; and even if it were not possible in practice to place a larger share of the load in each vehicle than the present average, we should have wagons of 5 tons capacity weighing 1½ tons, instead of others weighing 4 tons to carry the 1 ton average.

This capability of subdivision of traffic is one of the most important advantages which the narrow gauge offers; it involves the leading principle in railway economy, but it is an economy which I have shown—and I am borne out by all the weight of the evidence given before the Railway Commission—to be impossible on the broad gauge.

But it must be remembered—and this is a point not understood by some of the strongest advocates of narrow gauge—that such lines are of but little avail, unless they are provided with suitable locomotive power. If a line is made in all respects a miniature copy of a broad-gauge railway, with miniature rolling stock and miniature engines, its utility decreases, and its working capacity goes down, but its working expenses go up. In illustration of this I may quote the results of the Norwegian practice, where one of the narrow-gauge lines, carrying only a very small traffic as compared with that conveyed upon a broad gauge in the same country, shows its expenses to be out of all proportion; while the per-centages of the expenses to the receipts vary from 65.47 to 103.5 on the various narrow-gauge lines now built in Norway, a result that cannot be considered favourable.

If we look at the capacity of the engines on these railways, we shall see that they are capable of drawing, besides their own weight, 83 tons, 55 tons, and 84 tons respectively, up gradients of 1 in 70, 1 in 42, and 1 in 60, and it is worth noting that the proportion of working expenses to receipts *decreases as the power of the engine increases*. Although many other causes besides those of mere locomotive expenditure step in to interfere with results, the regular proportion is, I think, too clearly marked to be independent of this most important question. The capacities of the Norwegian stock and the maximum trains conveyed by the engines are shown in the diagram.

I refer again for a moment to the results obtained by the employment of the steam tender for dragging great loads. Mr. Sturrock found that he could, by adding a pair of steam cylinders to the tender of a locomotive, convey trains weighing one-half as much again as the maximum load carried by ordinary engines, with an extra expenditure of about 15 per cent.; and a train of any given weight can be conveyed for from 64 to 70 per cent. of the cost of such a train divided into two equal parts, which means a saving in the locomotive accounts of from 30 to 36 per cent. It is argued against me that an engine of my system is no more useful or profitable than two engines coupled together. My experience proves the contrary; so far as they go, the results with Mr. Sturrock's contrivance bear me out, and so do the results obtained by the working of MM. Meyer's engines (adapted from my own) in France.

If such a system as that which I recommend had been introduced into Norway, it is needless to point out that a considerable modification of the balance-sheet would have been the result.

To sum up, then, the requirements necessary for making a narrow-gauge railway perfectly efficient, we must have light, small stock, easily handled, and very powerful engines, capable of drawing heavy loads. The experience of the present year entirely bears out this assertion. We need only turn to the 3 ft. 6 in. Livny Railway in Russia, carrying regularly its 354 tons of train exclusive of engine, a duty accomplished by one Fairlie locomotive without distress to the permanent way, and up gradients, some of which are 1 in 80, of 4 or 5 miles in length, and with an economy shadowed forth long since by the crude appliances that were tried with a vague hope of achieving a similar result.

Again, as already stated, the introduction of the same system on the Festiniog Railway avoided the necessity of doubling the line of rails (a work which was actually commenced so far as preliminaries were concerned), by more than doubling the utility of the single pair. The diagrams show the change very strikingly, the one indicating the daily duty of the "Little Wonder," the other the similar duty of the ordinary engines of rather more than half the weight.

It now remains to point out as briefly as possible the circumstances that have led me to adopt a 3 ft. gauge, and to recommend that width for general introduction.

Experience has shown that 3 ft. 6 in. can be made a highly economical and efficient width, but it does not by any means follow that it is the most serviceable and most efficient, any more than it follows that the accidental 4 ft. 8½ in. was all that could be desired, even though an Act of Parliament had made it an article of belief.

On the contrary, as our knowledge and experience increase, we are enabled to approach more and more nearly to that happy mean, on either side of which is error. While, on the one hand, there is every necessity for obtaining such a gauge as will afford a good and useful width of vehicles, on the other it is necessary to avoid such narrow limits as would necessitate the introduction of too great overhang on each side of the rails. The 3 ft. gauge appears to me to comply with all the necessary conditions better than any other, and it is from no mere theorising that I lend all the influence I have towards its adoption. There is a certain amount of saving in first cost as compared with the 3 ft. 6 in.—not a large amount, but worth considering. This, however, I leave out of the discussion for the present. The all-important matters are to place upon the rails a thoroughly efficient stock that shall possess a maximum of capacity and a minimum of weight, and to supply engine power under the most economical circumstances, and I hold it to be easier to accomplish these objects on the 3 ft. gauge than upon any other.

I am led to this conclusion both by a comparison of the actual work done on the railways of the 3 ft. 6 in. gauge, with that which can be accomplished with the 3 ft. gauge, and because, having in view the practical requirements of goods traffic, I find that I can obtain an ample floor area with less dead weight than can be secured by any other width; on a wider gauge the dead weight increases, on a narrower one the capacity diminishes. A statement of the actual results of comparison will explain this more clearly and more quickly than could be done otherwise. On the Queensland 3 ft. 6 in. Railway, the composite passenger carriages are 6 ft. 6 in. wide and 6 ft. high inside. The capacity is equal to 34 persons, and the weight is 10 tons 5 cwt., or 6 cwt. per passenger; the second and third class carriages accommodate 48 persons, and weigh 9 tons 2 cwt., or 3.75 cwt. per passenger. The wagons average 14 ft. in length, 6 ft. in width, and weigh 3 tons 5 cwt. The covered wagons are 6 ft. high inside, and the open wagons have sides 30 in. high, the first would have a capacity of about 7 tons, the latter of about 5 tons, the respective proportions of paying load to weight being 2.15 to 1, and 1.54 to 1.

On the Norwegian 3 ft. 6 in. lines, the first-class carriages are 6 ft. 10 in. wide outside and 20 ft. long, weigh 4.6 tons, and carry 32 passengers, the proportion of weight per passenger being 2.9 cwt.; the second-class carriages have the same length and width, carry 32 persons, and weigh 2.4 cwt. per passenger. The covered goods wagons are 18 ft. long, 6 ft. 7 in. wide outside, weigh 3.7 tons, and carry 5 tons, the proportion of freight per ton weight of wagon being 1.2; this proportion is steadily maintained throughout the wagon stock, rising, however, as high as 1.6 to 1, while some of the more recent stock carries 6 tons instead of 5; of the increase of dead weight in these I have no data.

For a 3 ft. gauge, the stock that I construct is as follows: For first-class passengers the carriages are 18 ft. 6 in. long, 6 ft. 8 in. wide inside, seating 18 passengers, and weighing 3 tons 5 cwt., or 3 6 cwt. per passenger. For second-class, the carriages are 16 ft. 6 in. long, 6 ft. 6 in. wide, weighing 3 tons, and carrying 24 passengers, being 2.5 cwt. per passenger; the third-class carriages are of similar size, but seat 30 people, the dead weight being 2 cwt. per passenger. It will be noticed that these proportions are nearly identical with those on the Norwegian lines, but considerably less than those of the Queensland Railway.* My open wagons are 10 ft. by 6 ft. 6 in. by 2 ft. 10½ in. high, weighing 28 cwt. 3 qrs., and having a cubic capacity of 4 tons, equal to a proportion of 3 to 1; also, others for light goods, such as cotton, are 14 ft. by 6 ft. 6 in., with posts and rails 6 ft. 6 in. high

* Paper read before Section G of the British Association.

* The stock here described is on the type used in this country; a different type would require to be made to suit different tastes, as in America; for instance, carriages should have a central passage and rest on two bogies or trucks, with entrances at each end.

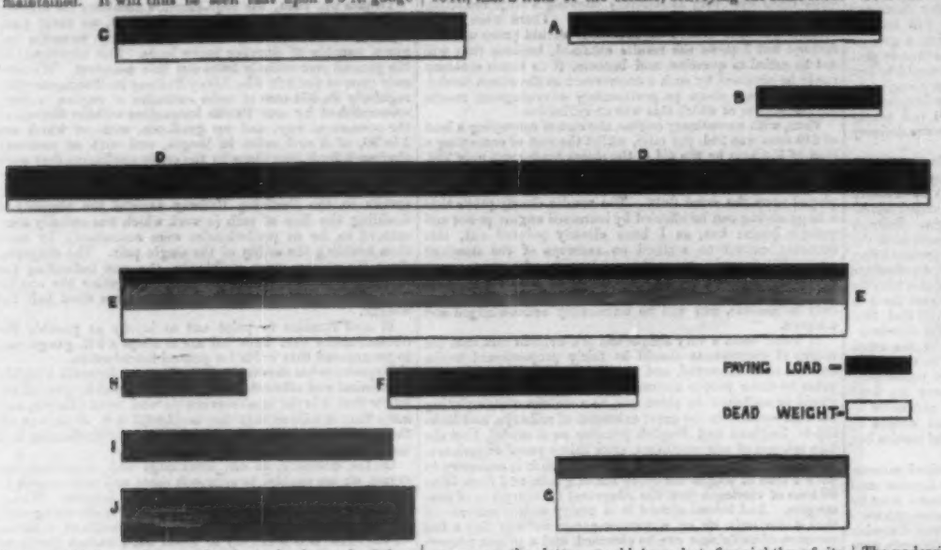
from floor, or, as we are now running them in Mexico, with a low ledge running all round only 6 in. high, on which cotton bales are piled in a similar manner to that on a street wagon or lorrey, and covered with tarpaulin. The covered wagons are 10 ft. by 6 ft. 6 in. by 6 ft., of 360 cubic feet contents, and weighing 33 cwt., equal to 3 tons of carrying capacity to 1 of dead load. In all this stock, as well as in the other classes required, the centre of gravity is kept low, and an angle of stability of 38° is in all cases maintained. It will thus be seen that upon a 3 ft. gauge I am enabled to place stock of ample size and of less weight than can be done on the 3 ft. 6 in. lines. In adopting this stock, I secure several advantages inseparable from the Fairlie gauge. The principal of these are; the reduced widths between the sole bars for the under frames of wagons and carriages, and lengths of wheel centres; these in turn affect the scantlings of material, the weight of the wheels, the size of axles, to carry certain loads. It has been argued that the excess of strength over the actual requirements for carrying, but necessary to resist the shocks and concussions incident upon shunting, &c., would not be affected by the gauge; and that if the gross weight of a train is maintained upon the narrow, that is now worked on the broad gauge, the wagon frame and couplings must be alike in weight to give equal strength to withstand sudden shocks and strains. Of course this is in itself quite true, and certain parts must be as strong in a train of given weight on a narrow as on a broad gauge. The force of the argument falls to the ground, if we remember that under present circumstances an average goods train, say of 250 tons, has only 50 tons of paying weight, the remaining 200 tons being stock. Now, on the narrow gauge, supposing that only one ton of goods was carried per truck, as in the case of the 4 ft. 8½ in. gauge, the dead weight required to carry it on my system would be only 87½ tons, making the total weight little more than half, and reducing the force of shocks upon the train in a proportionate manner, so as consequently to reduce the requisite weight of parts. Take, now, this same weight of paying load in a train, namely, 50 tons, and place it in the same portions in the wagons of the Norwegian 3 ft. 6 in. line, or in those of the Queensland Railway, and we shall find that the dead load carried runs up to 185 tons, or a close approximation to our English practice. Probably, therefore, this stock as built is not too heavy to resist the strains and shocks thrown upon it by reason of its own weight; but added to this reasoning there is the fact that by the mode of coupling employed on the Fairlie stock, and that destruction arising from shocks caused by sudden stopping and starting of the trains, especially when shunting at stations, is entirely avoided, and as the argument for strength in the present stock is founded solely on the necessity of resisting these shocks and bumps, it follows, and it must be admitted, that the instant these bumps, &c., are removed, the necessity for all this extra strength and weight is instantly removed also.

The foregoing figures really mean that to carry 50 tons of goods on the Norwegian or Queensland 3 ft. 6 in. gauge, the proportion of 1 ton per waggon being preserved, 92 per cent. of the weight of rolling stock used on the 4 ft. 8½ in. would be required, as against only 45 per cent. on a 3 ft. gauge, showing a saving of 47 per cent. on the latter as compared with the 3 ft. 6 in., as shown in the diagram. Of course, if the wagons were loaded up to full capacity, these percentages would be very much changed.

It is to this point especially that I wish to direct your attention, as upon it the economy of the 3 ft. gauge rests. Whatever saving may be effected in first cost may be lost sight of, the great advantage lying in the saving effected in working expenses. Every ton of dead weight saved goes towards securing the prosperity of the line, and if we can obtain the ample platform which the 3 ft. gauge gives, combined with so much saving in weight, there is nothing left to be desired. In making my comparison, I have taken matters as they exist in Queensland and in Norway. The able engineers of those lines have designed their stock as economically as they found possible. I should have thought *the dead weight might have been reduced to a certain degree*; but of course I am aware that no such reduction as may be made on a 3 ft. gauge could be achieved.

Before I conclude, I may refer to one or two prevailing errors which exist with regard to the narrow gauge, and which are often urged against it. It is said that with a 3 ft. or 3 ft. 6 in. gauge, a far larger amount of siding and goods shed accommodation is required. Is it not sufficient to point out, as the wagons carrying the same amount on the latter as on a wide gauge are but some 10 ft. long as compared to 16 ft., that a train of the former, conveying the same loads as one on the latter, would have but five-eighths of its length? Here, again, the axiom of subdivision of traffic is applicable in all its force.

Again, a common notion—and one that was strongly urged when the discussion concerning India was in progress—is that narrow-gauge railways may be constructed in difficult and hilly countries, but not on level and favourable ground. Doubtless this idea has grown from the fact that the saving of construction in the former localities is greater than in the latter. But, as I have already stated, the economy in the cost of construction is altogether subordinate to the greater and constant economy in daily use. The fact is that narrow-gauge lines are useful everywhere, are needed everywhere; the saving in their first cost rises and falls with the country over which they pass, and, always considerable, is greatest where precipitous districts demand lines that creep around and up hill-sides; but the subsequent economy is not variable; it is always what I have shown it to be, when narrow-gauge railways and their equipments are worked, as everything should be worked, with a view to progress and development.



Explanation of the Diagrams.

The diagrams on the present page represent various proportions between dead weight and paying load, on railway rolling stock, as follows:

A shows the average load carried in daily practice by the Fairlie engine "Little Wonder" over the Festiniog Railway, 1 ft. 11½ in. gauge, the average up grade being 1 in 92. The engine weighs 19½ tons, the weight of load is over 107 tons, and the proportion of paying to non-paying load is 3 to 1.

B shows the average daily working of the ordinary engine, weighing 10 tons. The load carried is a little in excess of 43 tons.

[The above diagrams show very clearly the capacities of the Festiniog Railway after and before the adoption of the Fairlie engines on it.]

C shows the maximum load of 120 tons carried by the most powerful engines on the 3 ft. 6 in. Norwegian Railway up gradients of 1 in 90. The proportion of paying to dead weight is 1.6 to 1.

D represents the daily working of the freight train of the Imperial (Russian) Livny Railway, 3 ft. 6 in. gauge, up gradients of 1 in 80. The gross load conveyed (exclusive of engine) is 354 tons, of which 260 tons are paying weight. The engine weighs 42 tons, and the proportion of paying and non-paying loads is 2.78 to 1.

E represents the actual ratio between dead and paying loads conveyed in a 250-ton goods' train on the 4 ft. 8½ in. gauge; the lighter tint indicating the maximum capacity of the stock, giving 1.8 to 1 of paying to dead weight.

F shows the weight of a train on the 3 ft. gauge carrying the same paying load, 50 tons, as that conveyed by the wagons on the 4 ft. 8½ in. gauge, as shown in the previous diagrams.

G is a diagram showing the existing ratio between dead and paying weight, on passenger trains, 4 ft. 8½ in. gauge, as well as its maximum capacity, being 30 to 1 and 3.3 to 1 respectively.

J I H are diagrams showing the comparative dead weights of trains on the 4 ft. 8½ in., 3 ft. 6 in. and 3 ft. gauges respectively, employed to carry 50 tons of paying load, every wagon of each train being loaded up to the present average weight of 1 ton per wagon.

In the course of the discussion which followed the reading of Mr. Fairlie's paper, General Strachey head of the Railway Department for India, detailed certain facts which he had observed on the Festiniog and other narrow railways in India and elsewhere, and expressed his entire concurrence with Mr. Fairlie as regards the economy and capacity of the narrow gauge. He said that India was, as compared with England, a poor and an extensive country, requiring very long lines of railway, on which there could as yet be only limited traffic. The Indian Government had no capital for the construction of railways, and could only make lines that would be self-supporting. They were, therefore, compelled to construct them in the cheapest manner compatible with efficiency, and the problem thus presented to them had been effectually solved by the narrow gauge, which must, at no distant time, become the type of construction in India.

THE ALBERT BRIDGE AT CHELSEA.

THE Albert Bridge Company have taken every possible advantage of the opportunity afforded by the renewal of their powers by Parliament in May last, to push on the works of their bridge at Chelsea. It is now only about six weeks since the contract was finally settled and signed, but within that period the timber piling has been re-arranged, and a staging 6 ft. wide thrown across the river. This has been effected by Mr. F. W. Bryant, the resident engineer of the works, and who occupied a similar position on the Westminster and Blackfriars Bridges. The staging was completed on Monday last, upon which occasion the directors of the company and their friends visited the works. The bridge—as provided for in the company's Act of Parliament—will be upon Mr. Ordish's rigid suspension principle, as carried out by him in Austria and India. The roadway of the structure will be 710 ft. long, and the total width will be 40 ft., including the two footways. There will be three river openings, one of 400 ft. in the centre, and one of 155 ft. at each end. The underside of the platform, at the centre of the bridge, will be 21 ft. from Trinity high-water mark, whilst at the abutments the height will be reduced to 10 ft. Each of the piers carrying the towers will consist of cast-iron cylinders 15 ft. in diameter, the foundations also being composed of cast-iron cylinders 21 ft. in diameter. There will be four of these piers, in pairs under each pair of towers, which latter will be of cast iron, and highly ornamental in design. Each pair of towers will be connected across the roadway, and at a height of 60 ft. above its level, by ornamental iron arched bracing. The roadway and the two pathways will be clear of all obstruction from end to end of the bridge, as the towers will be placed outside the parapet girders. The date of completion is fixed for the latter end of April, 1872, and with a favourable winter, and a continuation of the activity which at present prevails, we see no reason why the contract time should not be kept.

THE ALLAN LINE.—The Allan Steamship Company of Montreal is stated to be in correspondence with a firm at Victoria, Vancouver's Island, with respect to the establishment of an agency at that port. It is also stated that an agent for the company has been accepted at San Francisco.

THE AMERICAN LAKES.—An important improvement in the navigation of the American lakes, useful equally to the Canadians and the Americans, was recently opened to commerce. Formerly the navigation of Lake St. Clair was impeded by the circumstance that the waters of the St. Clair river, flowing from Lake Huron, poured into it through several channels, their greatest depth being 10 ft. The channel generally used was narrow and crooked, with a depth averaging not over 15 ft., and was very difficult to navigate even in daylight. It had been several times dredged; but this was expensive, and only a temporary remedy. Several years ago General Thomas J. Cram, United States' Army, suggested the plan of constructing a ship canal, beginning near the mouth of St. Clair river, by which vessels could be passed across the lake in a direct line to the entrance of Detroit river, which flows into Lake Erie. This canal was begun in 1868, and has just been completed at a cost of about 428,000 dols., having on the 24th of July been formally accepted by the United States' Inspector. It consists of two dykes 7221 ft. long each, 40 ft. wide, and made of clay and sand, enclosed in timber frames. At each end of the western dyke, which is towards the Michigan shore, lighthouses are being erected. The dykes are covered with willow trees, set out in ornamental figures. The canal, including bays at each end, which extend beyond the dykes, is 8421 ft. long, the width at the bottom of the entrance to each bay being 416 ft., while between the dykes the bottom of the canal is 300 ft. wide. The dykes on either hand are raised 5 ft. above the water surface, while the piles enclosing them are driven 12 ft. below the bottom, about 7 ft. being solid clay. The entire work is constructed in a substantial manner, the canal having sufficient depth to pass vessels drawing 15 ft., and a constant stream of craft of all characters is now passing through. A current of two miles an hour runs through the canal, being the current of the St. Clair river, and from the southern end the vessels, having uniformly deep water, can pass in a direct line to Detroit river. It is proposed to deepen the channel so as to allow vessels of 16 ft. draught to pass, but this will require an additional appropriation from Congress. This ship canal is a great improvement in the navigation of the St. Clair flats, the value of which is appreciated by the *heavy trade from both nations passing across that lake.*

THE "WATERSTAAT" OF HOLLAND.

No. IV.

(*Continued from page* 112.)

In 1848 the revised constitution was established, and on the 9th of February, 1849, a royal decree was issued, ordering the "Ninth Organisation of the Waterstaat." To the influence of L. J. A. van der Kun, although his views were not wholly carried out, this organisation is much indebted. His sound technical knowledge, varied experience, and clear judgment, as well as his prudent management, eminently fitted him to be an adviser on the occasion, while they justly entitled him to be ranked among the first hydraulic engineers of his time. He was opposed to the division of the kingdom under two inspectors, without an Inspector-General. In his opinion, the Minister of State was not in a position to promote the technical unity necessary, since it was not to be expected of him that he should enter deeply into technical details. On the 13th of August, 1848, his advice to the Minister for the Home Department was:—"To attain technical unity, an Inspector-General ought to be appointed, or the technical matters of the Waterstaat must be, as a sub-department of the Home Office, committed to a director-general, who need not be of the corps of engineers, provided that he possess sufficient knowledge and influence to enable him to protect the interests of that department of the government with which he associates his name." In the reorganisation of the corps this advice was not followed. The corps of engineers of the Waterstaat was composed of 2 inspectors, 5 engineers-in-chief of the first class, 4 engineers-in-chief of the second class, 15 engineers of the first class, and 15 engineers of the second class. Compensation for travelling expenses, &c., was to be regulated by subscription. The minister was empowered to appoint 20 surveyors of the first class, 40 of the second class, 30 of the third class, and 10 of the fourth class, besides as many supernumeraries to the Waterstaat as might be required, who were to be trained under the direction of the superior officers to become surveyors, and to whom the prospect of promotion was held out. This latter provision was chiefly due to the consideration that the title of civil engineers was accorded to the pupils immediately on their leaving the Academy at Delft, whereas Van der Kun was of opinion that the right to that title could be obtained only by the acquisition of practical knowledge. By this, the complicated arrangement in consequence of one of the decrees of the 17th December, 1819, was to a great extent done away with; but still there was a defect, inasmuch as the other decree of that date was still in force, with regard to the national works; and the measure was confirmed by which those works were placed under the control of the states, and maintained at the cost of the provinces. Though the organisation of the corps of engineers might be improved, yet their sphere of action was not clearly defined; which probably induced the states of the provinces of Groningen and Guelderland to renounce the employment of Government engineers and to appoint departmental engineers. Thus the difficulties arising from the uncertainty of the position in which the officers of the Waterstaat found themselves with regard to the different authorities were not removed, nor was the conflict dating since 1798 between the States-General and the provincial states as to who should rule, ended. Generally when disasters or trying circumstances arose a national management was called for; on the contrary, when rest and prosperity were restored, such arrangement was less and less thought of; moreover, the relation between the provincial states and the Polder Boards frequently occasioned trouble. By a law (6th July, 1850) the competency of the provincial states in matters concerning the Waterstaat was defined on the one side; on the other by a law (12th July, 1855), temporary provision was made in certain cases, one of which was that when two or more provinces were unable to agree upon matters in which their common interests were concerned, the king, with the advice of his council, should settle the matter by decree. The law next in importance to the interests of the Waterstaat was that of 28th August, 1851, by which expropriation for the public benefit was ordered. By this law, although the principle of taking preliminary possession was rejected as being opposed to the constitution, and on its introduction especially, much time was lost on account of the formalities it imposed, an important step forwards was nevertheless taken in the domain of public works.

After the organisation of 1849, J. H. Ferrand and L. J. A. van der Kun were appointed inspectors. At last, on the 30th of December, 1857, the long-felt want of a head to the corps of the Waterstaat was supplied, in virtue of a royal decree, by which it was ordered that in addition to the two inspectors, an inspector-in-chief should be appointed at the head of the Waterstaat from the 1st of January, 1858. L. J. A. van der Kun was appointed inspector-in-chief, and J. H. Ferrand and H. F. Fynje inspectors, the former with the title of inspector-in-chief. About a month afterwards Ferrand resigned, and F. W. Conrad was appointed inspector. Thus the three eldest pupils of Delft were together at the head of the Waterstaat, and remained there till 26th January, 1864, when Van der Kun died. Of what united strength can do in the domain of science the performances of these three men afford sufficient proof. Let us take, for instance, the important improvement of the rivers, the forming of the New Merwede, the projected and partly accomplished improvement of the waterway from Rotterdam to the sea, the separation of the Maas and the Waal at St. Andres; the canalisation of the Dieze, and the important river works on the upper Maas, in consequence of the treaty of 1863. Besides these works, which more immediately belong to the Waterstaat, this period is remarkable by (*a*) the completion of the draining of the Lake of Haarlem, which the government made known in no other way than by announcing it in the *Gazette*, with the four simple words "The Lake is dry." But the committee, who were charged with the work, rendered less indelible the result of their 19 years' labours by dedicating their last sitting, on the 12th of April, 1858, to ordering the execution of a medal, after a design by F. W. Conrad, to commemorate their achievement; (*b*) the making of the railroad from Antwerp to the Hollands diep, with a branch from Roreudaal to Breda; (*c*) the reduction of the gauge of the railway between Amsterdam and Arnhem, its extension to the Prussian frontiers, and junction with the German lines; (*d*) the completion of the line from Maastricht to Aix-la-Chapelle and the commencement of a line from Maastricht to the Belgian frontiers in the direction of Hasselt; (*e*) the line from Maastricht to Liege; (*f*) the canals in Oberyssel, commenced by De Kastecle and finished by Stieltjes; (*g*) the canal in Dreuthe, with the widening of the Hoogeveen and Orange Canals, as well as the discharging canal to the Groose Vecht, near Ane; (*h*) the canals in Groningen and the canal from Assen to Groningen; (*i*) the canal from Maastricht to Liège under the direction of F. W. Conrad and J. R. T. Ortt; (*k*) the improvements of the Dutch yssel. In consequence of the law of the 18th of August, 1860, by which the construction of railways was undertaken at the expense of the Government, other lines which had been projected, but could not be carried out, have since been completed or are in a state of progress. The works required for these railways, including the construction of bridges across the principal rivers; the canal through Tuid Beveland; the grand ship canal through Walcheren, the harbour works at Flushing and those projected for Harlingen, the damming of the East Schelde and of the Sloe, as well as the cutting of the canal from Amsterdam to the North Sea; the improvement of the Great North Holland Canal; the making of the Waterway from Rotterdam to the sea, with the laying of the Government telegraphs, will make this period memorable in the annals of the country. No period in its history can be pointed out, in which plans so grand have been completed, in which the knowledge of the engineers has been so largely developed, or in which that knowledge has taken so high a flight.

The law published on the 21st of August, 1859, we mention here, since, in consequence of it, a separate board for the supervision of railways was instituted, and thus one of the ideas conceived by F. W. Conrad shortly after his appointment as commissioner to the Dutch Railways, and of which the development was found in a confidential note among his posthumous papers, was realised. After the death of Van der Kun the place of inspector-in-chief remained vacant till the 1st of May, 1866, when it was filled up by the appointment of F. W. Conrad as inspector-in-chief, while to the places of inspectors were appointed H. F. Fynje and J. A. Beyerinck, the former with the title of inspector-in-chief. On the 1st of October, 1867, H. F. Fynje, after fifty years' service, resigned. Thus the three inspectors were F. W. Conrad, J. A. Beyerinck, and C. Brunings, the last of whom is still in active service.

(*To be continued.*)

BURT'S DREDGING MACHINE.

We illustrate, on the following page, an arrangement of dredging machinery designed by Mr. James Burt, of Velsen, North Holland, which has for its principal object the protection of the bottom bearing of the pump shaft from the injurious action of sand or other gritty matter, and to give to the end of the suction pipe a constant reciprocating motion by mechanical means, for loosening the material to be lifted in conjunction with the water.

In this arrangement a centrifugal pump, mounted on trunnions, is employed, supported by two bearings fixed on a floating vessel in such a manner as to admit of the suction pipe taking a radial motion whilst being worked. The pump, which may be driven by steam or other power, discharges the dredged materials through one of the trunnions, either into barges alongside, or by means of floating pipes connected with the shore or place for depositing the dredged materials.

The first-named improvement is effected by causing the end of the pump shaft to work on a piece of leather, supported by india-rubber of such thickness as will prevent the passage of water, the pivot being lubricated with oil contained in a cavity bored in the centre of the shaft for that purpose, and from whence it can be expelled or withdrawn at intervals by means of a syringe when it is desired to renew it.

The second improvement is attained by arming the end of the suction pipe with prongs for tearing up or otherwise loosening the materials to be dredged or operated upon. These prongs are kept continually vibrating in any required direction by means of the special machinery, which motion, combined with a transverse movement of the vessel, will bring a great amount of matter within range of the action of the pump.

The mechanism for giving the motion to the suction pipe consists of a barrel on which the chain for elevating and depressing the pipe is wound; this barrel which receives motion in opposite directions through gearing from a pulley driven alternately by a straight and crossed strap, carries at its outer end a pinion giving motion to a rack; this rack is furnished with tappets or projections that may be fixed at any desired part of the rack, which coming in contact with a bent lever alternately bring the straight and crossed straps on to the fast pulley, and thus reverse the action of the machinery. In order to prevent the pump or pipe running down whilst the straps are being shifted by the reversing gear, a worm wheel and worm or screw are introduced to effect the same purpose as is usually attained by a ratchet wheel and detent. A counter weight is also added for the purpose of increasing the speed of the oscillation when working with the pipe nearly vertical.

In the accompanying drawings Fig. 1 is an elevation of the machine, Fig. 2 a plan, Figs. 3 and 4 are plan and elevation of lifting gear, and Fig. 5 an enlarged view of the pivot bearing.

The centrifugal pump, A, is fixed in framing and supported by trunnions, B, B^1, on a floating vessel; this pump receives motion by the shaft, C, which shaft is actuated by means of the bevel wheels, *d*, *d*, and the pulley, *e*, from the steam engine, *f*; G is the suction pipe, and *h*, *h*, are prongs fixed to the end thereof for loosening the materials to be dredged; *g*, is a rod opening and closing a door, *g'*, for obtaining access to the interior of the pump. The distance of the pump from the surface of the water is not material, provided it be such that no portion of the pump casing during its oscillation comes out of or above the water so as to draw air. I is the delivery pipe and is carried through the trunnion, B^1, where it is connected by means of an india-rubber pipe, B^2, with floating pipes, or the discharge can be made into a barge or other vessel alongside; *j*, *j*, are studs for attaching the two irons, *k*, *k*, one of which is connected with the lifting gear, *l*, and the other with the counter weight, *m*.

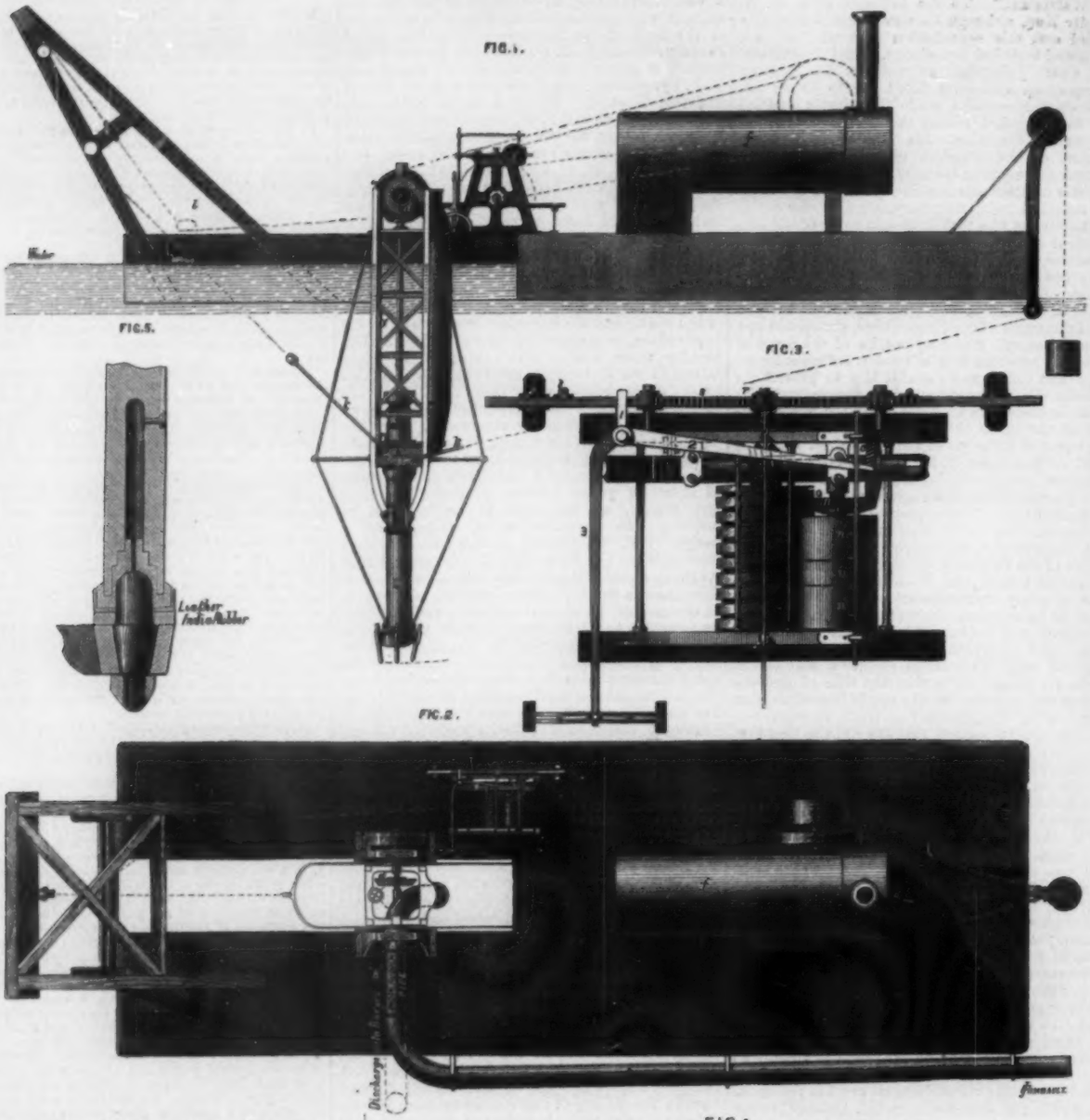
In Figs. 3 and 4, *n* is the fast pulley, and n^1, n^2, are loose pulleys; the pulley, *s*, which receives the power from the engine by either a straight or a cross strap, drives by means of the two bevelled wheels, *o*, *o*, and the worm, *p*, the barrel, *q*, on which barrel the chain for elevating and depressing the suction pipe is wound. The axle of the barrel, *q*, carries on its outer end a pinion, *r*, giving motion to the rack, 8, on which rack are fastened where desired the two tappets, *t*, *t*; *u* is an upright shaft carrying the arms 1, 2, and 3. The arm 2 gives motion to the bar, *v*, for shifting either of the straps on to the fast pulley, *n*, which movement is imparted to the said arm 2 by the tappets, *t*, *t*, coming in contact with the arm 1; the barrel will then continue to revolve in one direction until the other tappet comes in contact with the arm 1; this will cause by means of the arm 2 a change of the straps on the fast pulley, and thus reverse the action of the machine. The arm 3 with the lever 4 is for the purpose of reversing the crab by hand when desired. It will readily be seen that by fixing the tappets, *t*, *t*, on the rack, 8, at various distances apart a smaller or greater amount of oscillation of the pump will be obtained.

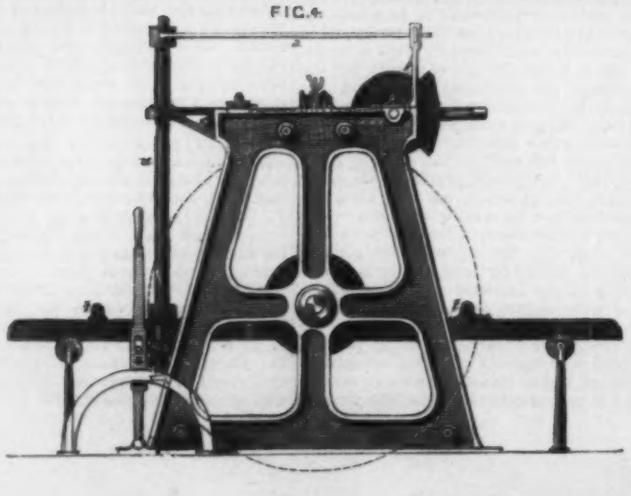
Fig. 5 is a section of the lower end of the shaft, *c*, showing the pivot bearing and the mode of lubricating it, and also the means employed for excluding sand and other gritty matters. The space between the bottom of the bearing cup, and the iron support of the pivot is filled, so as to be water-tight by a disc of india-rubber which is covered on the top with leather as shown. Provision is made for lubrication by boring a hole in the centre of the shaft for the purpose of containing the oil, which oil can be introduced or withdrawn or expelled by removing the screw, as shown; to expel the oil it is necessary to slightly lift the shaft off the leather disc and to apply a syringe at the screw hole.

DREDGING MACHINERY.

DESIGNED BY MR. JAMES BURT, ENGINEER, VELSEN, NORTH HOLLAND.

(*For Description, see preceding Page.*)



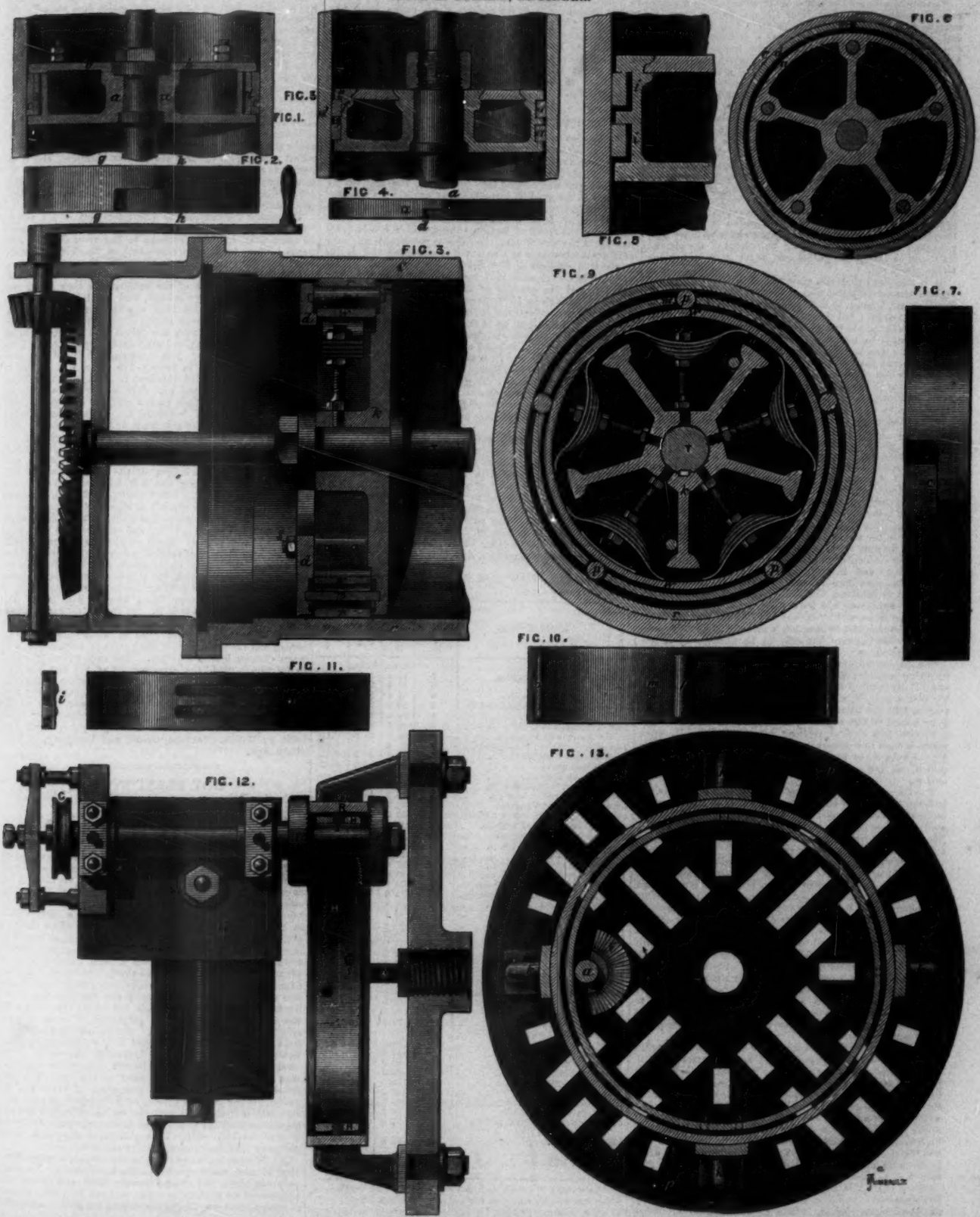


ALGERIAN RAILWAYS.—In the course of last year, the Paris, Lyons, and Mediterranean Railway Company expended 835,263*l.* upon the lines which it is constructing in Algeria, viz., upon the Algiers and Oran line, 586,399*l.*; upon the Philippeville and Constantine line, 223,553*l.*; and the balance for rolling stock. The lines undertaken are now virtually terminated. It will be remembered that they were commenced originally by Sir Morton Peto, some 14 years since. The aggregate expenditure made upon them to the close of last year was 5,796,555*l.*

THE ST. CLAIR SHIP CANAL.—A ship canal connecting Lake Huron and the St. Clair river with the Detroit river, has been formally accepted by the United States, the work being declared to have been executed according to contract. The canal was commenced in the spring of 1868, and has cost about 428,000 dols. The work consists of two long dykes, each 7221 ft. long, 40 ft. wide, and constructed of sand and clay enclosed in frames of timber. At each end of the west dyke, which is towards the Michigan shore, are buildings in course of construction as lighthouses; the one at the southern end is nearly completed, and the foundations only of the other have been finished. The canal itself, embracing the distance it has been dredged out, is 8421 ft. long, including 7221 ft. of dykes and two bays, the upper one 400 ft., and the lower one 800 ft. long. The width of the canal at the bottom at the entrance of the bays is 416 ft., and it is 300 ft. between the two dykes.

PISTON FITTING APPARATUS USED ON THE KAISERIN ELIZABETH RAILWAY.

HERR B. CURANT, ENGINEER.



HERR B. CURANT, the engineer of the Kaiserin Elizabeth Railway, has contributed to Herr Heusinger von Waldegg's *Organ für die Fortschritte des Eisenbahnwesen*, a memoir, containing some interesting particulars of the mode of constructing the pistons for locomotive engines in use on his line, which appear to us well worthy of attention. Herr Curant objects to pistons fitted with ordinary cast-iron rings in the manner shown in the annexed Figs. 3 and 4, on the score that after being some little time at work, the rings become loose laterally in the manner shown to an exaggerated scale in Fig. 5, and that then facilities are afforded for the passage of steam down the sides of, and under the rings, and thence through the spaces, *d d*, Fig. 4. Herr Curant admits that in fast running engines this escape of steam will be small, but he regards it as of considerable importance in the case of

engines working with a moderate piston speed, and he urges moreover, that all pistons fitted with rings of this kind should be guided on both sides, so as to avoid any tendency to twist the rings by the piston dropping.

We ourselves regard the piston above alluded to in a much more favourable light than Herr Curant, as the rings, if made of a proper material, will run for a very long period, and, when worn, can be renewed at a trifling cost. Herr Cursant's objections to the ordinary type, however, have led him to adopt largely on the Kaiserin Elizabeth Railway the form of piston shown by Figs. 1, 2, and 6 of the preceding engravings, and it is of this piston, and the mode of constructing it, that we desire more especially to speak here.

Herr Curant's piston consists of the body, *a*, the cover-plate, *b*, a cast-iron piston ring, *c*, and a circular steel spring (self-acting), *d*. The cover-plate is fastened to the body of the piston by means of five bolts, and the piston rod is guided at both ends of the cylinder. This piston is not so simple in construction as that shown by Figs. 3 and 4, but it can be made, and kept, with a little care, thoroughly steam-tight. The piston ring and spring are fitted by grinding between the cover plate and the body of piston, and a pin fixed in the latter prevents their turning round. The space between the spring and body of piston is filled up by thin layers of sheet iron, which, however, have no other purpose than to prevent a swinging movement of the piston: for the same reason two guides are, as we have said, given to the piston rod.

It is necessary that the spring, *d*, should well cover and tighten against the piston ring at the part where the ring, *c*, Fig. 2, occur, because at that point an escape of the steam would be possible; but this can easily be arranged. Herr Curant states that if the piston rings become worn or loose they can easily be refitted and ground, and a piston of this construction may be repaired perhaps twenty times without renewing even the smallest part.

The cast-iron piston rings are made at the Kaiserin Elizabeth Railway in the following manner: For a steam cylinder 17 in. in diameter, a cast-iron hollow cylinder, 18 in. in diameter outside, ¾ in. thick, and 36 in. high, is cast; and out of this cylinder are cut twelve rings, each 3 in. high and ¼ in. thick. The cylinder is turned for this purpose outside and inside, and is cut into rings, each 3¼ in. high, and these rings are then cut open in the manner indicated in Fig. 7. The horizontal cut, *c*, which connects the two vertical cuts (each 1¼ in. wide) is only $\frac{1}{17}$ in. wide. The ring after being hammered until the horizontal cut, *c*, is entirely closed, is pressed together on the face plate of a lathe to 17 in. in diameter, and is then turned to its normal height and thickness. On account of the tremor of the lathe and the cutter, as well as on account of the soft and hard places in the cast iron, the ring cannot be finished by means of the ordinary cutting tool in the lathe in such an exact manner, as to be completely ready for grinding; and this additional work, if done by hand would take considerable time. In order to reduce this labour and to facilitate the fitting and grinding, therefore, a shaping apparatus has been constructed, which may be fixed to any lathe, and by means of which the two side surfaces of the ring can be completely finished in about twenty minutes, when the ring has only to be finished by a few minutes' grinding.

The shaping apparatus just referred to is arranged in the following manner: To the face plate, *p*, of a lathe (Figs. 12 and 13) are secured four brackets, *k*, for the purpose of fixing the piston ring, R, a ring, H, being placed inside the piston ring, so that the latter can be firmly fixed within the brackets, *k*, by means of the adjusting screws, S. A common slide rest, with two vertical motions, carries a plate, M, upon which is fixed in bearings the axis, A, with the two cutters, F; the axis, A, is provided on the other end with a rope pulley, G, for communicating a rotatory motion to the cutters.

The face plate and cutters rotate in opposite directions. It is found best to have only one cutter acting at one time, and on one side of the ring being finished, to move the slide in such a manner that the second cutter is brought into action. The steel ring belonging to the same piston as the cast-iron ring, is prepared in a similar manner.

Herr Curant does not re-bore steam cylinders which, by wear and tear, may have lost their exact cylindrical shape, because he considers that in the first place there is no decided necessity for it, and, secondly, because reboring the cylinders necessitate their being renewed too soon. But it becomes necessary to fit the piston rings exactly to the inner surface of the cylinders; that is to say, the shape of the rings has to be made to correspond to that of the cylinder. For this purpose it has been usual to hammer the rings round the surface of the cylinder until the rays of a light placed in the cylinder could not penetrate between the surface of the ring and that of the cylinder; but this hammering process takes some time, and requires a skilful workman, so that, to avoid it, an apparatus has been constructed, by means of which each ring can be rolled to the shape of the corresponding steam cylinder.

This apparatus, which is shown by Figs. 8 and 9, consists of the body of an old piston, *b*, and an open cover plate, *d*, which is fastened by the screws, *s*; the openings in the cover plate are necessary for getting access to the springs, *f*. The cast iron and open piston ring, which has to be rolled to fit the cylinder, is marked *r*, and *w* is another open steel ring, which acts as a spring, and which is connected with the body of the piston by means of the pin, *a*, in such a manner that both must turn round together. Between the piston ring and the steel ring is placed a third and wider ring, *m*, which is, however, not cut open, but which carries the five steel rollers, *p*, as shown in Figs. 9 and 10.

When the whole apparatus is put together in the more or less worn-out cylinder, *c*, and the springs, *f*, are screwed up, the elastic open ring, *w*, is then pressed against the rollers, which act thus against the piston ring, *r*, under treatment. A thin plate, *i* (Fig 11), has to be attached at the point where the steel ring, *w*, is cut open, in order to prevent the lapping over of both ends, or otherwise the rollers would not pass over that place; this arrangement is shown in Fig. 11. By turning round the shaft, T, the whole apparatus is put in motion, with the exception of the piston ring that has to be rolled. A continued rotation of the apparatus, and a repeated tightening up of the springs, *f*, will cause the ring to be rolled to a shape corresponding with that of the cylinder; and although this mode of operation does not require less time than the hammering of the ring, it has the advantage of not requiring a skilled workman, but can be performed by any common labourer. The arrangement is evidently an application of Dudgeon's well-known tube expander in a modified form.

CLEVELAND BLAST FURNACES.

*A Description of the Ayresome Iron Works, Middlesbrough, with remarks upon the alteration in size of Cleveland Furnaces during the last ten years.**

By Mr. JOHN GJERS, Middlesbrough.

THIS paper was divided into two parts, the first having reference to the gradual increase in the size of the Cleveland blast furnaces, and the second part being a description of the Ayresome Iron Works, Middlesbrough. The author stated that the credit of having proved that a considerable increase in the size of blast furnaces is practicable and may be of great advantage as a means of economising fuel, is due to the iron smelters of Cleveland. The first blast furnace was built in Cleveland in 1851, by the late Mr. John Vaughan, who followed the practice of older districts, and made his furnace 42 ft. high by 15 ft. diameter at the bosh. Up to 1858 there was a gradual increase in size, the furnaces in that year being 50 ft. in height by 16 ft. bosh. The results of this increase in size were so satisfactory that Mr. Vaughan was led in that year to re-build one of the Whitton furnaces, and to increase their size from the original 42 ft. by 13 ft. to 61 ft. high by 16 ft. 4 in. bosh. This may be said to be the first decided step towards the great increase in size which followed, the comparative results being so much in favour of the large furnace over the original small one that it soon became an undoubted fact that economy was to be found in that direction.

Although the scientific reasons which led to a saving of fuel through an increase in size, were at that time not clearly understood, yet the practical results obtained were so beneficial that they culminated in that revolution unparalleled in the blast furnace history of any district, in which all the original furnaces and plant were razed to the ground, and new ones on the now established improved principle were built in their stead. The author stated that the way in which this increase in size of furnaces was carried out, together with numerous other improvements, reflected credit on the Cleveland ironmasters, and tested their enterprising spirit.

The following Table gives the furnaces in the order of their respective dates:

Date.	Name of Firm.	No. built.	Height.	Diameter of bosh.	Cubic capacity.
			ft. in.	ft. in.	
1851	Bolckow and Vaughan ...	3	42 0	15 0	4,595
1853	Bell Brothers	6	47 6	18 6	8,174
1853	Bolckow and Vaughan	6	54 0	15 0	7,116
1853	Gilkes, Wilson, Pease, and Co.	2	45 6	14 6	5,100
1854	Cochrane and Co.	4	55 0	16 0	7,175
1854	B. Samuelson and Co.	3	50 0	16 0	6,959
1854	Bolckow and Vaughan ...	3	54 0	15 0	7,116
1854	Gilkes, Wilson, Pease, and Co.	2	55 0	14 6	6,800
1855	Stockton Furnace Co.	3	50 0	16 0	6,341
1856	Norton Iron Co.	3	50 0	15 0	6,000
1856	Thomas Vaughan	6	58 0	16 0	7,000
1856	Hopkins, Gilkes, and Co.	2	56 6	16 0	7,200
1858	Jones, Dunning, and Co. ...	3	58 0	17 0	8,000
1858	Bolckow and Vaughan ...	1	61 0	16 4	7,980
1861	Gilkes, Wilson, Pease, and Co.	1	55 0	16 0	7,700
1861	William Whitwell and Co. ...	3	60 0	20 0	12,778
1862	Bolckow and Vaughan	2	75 0	16 6	11,985
1864	B. Samuelson and Co.	4	69 0	20 0	15,500
1864	Thomas Vaughan	3	70 0	15 0	12,000
1864	Lloyd and Co.	4	67 0	20 0	15,000
1864	Thomas Vaughan	6	81 0	19 0	16,000
1865	Stevenson, Jaques, and Co. ...	3	70 0	22 0	17,000
1865	Gilkes, Wilson, Pease, and Co.	2	75 0	21 0	17,700
1865	Bell Brothers	2	80 0	20 6	18,500
1865	Bolckow and Vaughan ...	2	95 6	18 0	18,650
1865	.. ..	1	75 0	20 0	13,972
1866	Hopkins, Gilkes, and Co. ...	2	75 0	20 0	20,000
1866	Swan, Coates, and Co.	2	75 0	20 0	16,000
1866	Bell Brothers	2	80 0	17 0	11,500
1867	Norton Iron Co.	2	85 0	25 0	26,000
1867	Cochrane and Co.	2	76 0	23 0	20,894
1868	Gilkes, Wilson, Pease, and Co.	1	75 0	24 0	22,500
1868	Stevenson, Jaques, and Co. ...	1	70 0	23 0	18,000
1868	B. Samuelson and Co.	1	69 0	21 6	16,000
1868	Lloyd and Co.	2	80 0	21 6	18,000
1868	Jones, Dunning, and Co. ...	3	78 0	18 0	12,000
1869	Bolckow, Vaughan, and Co. ...	2	95 6	23 0	25,940
1869	.. ..	1	95 6	23 0	28,809
1869	Thomas Vaughan	3	85 0	25 0	26,000
1870	Bell Brothers	4	80 0	25 0	25,000
1870	Stockton Furnace Co.	2	80 0	24 0	24,613
1870	Swan, Coates, and Co.	1	75 0	23 6	22,229
1870	Cochrane and Co.	2	90 0	30 0	41,149
1870	Gilkes, Wilson, Pease and Co.	2	85 0	27 0	32,000
1870	B. Samuelson and Co.	2	85 0	28 0	30,000
1871	Bolckow, Vaughan, and Co. ...	2	95 6	24 0	28,950
		building			
1871	Lackenby Iron Co.	2	85 6	25 6	26,670
		building			
1871	Gjers, Mills, and Co.	2	85 0	25 0	26,660

It is worthy of notice that, with only one or two exceptions, there are now no furnaces remaining of all those built prior to 1859, so that, practically, the present plants working in Cleveland date since then. The author stated, it was his opinion, that the useful maximum of both height and diameter of bosh had already been attained, if not exceeded, and that there were already signs of a retrograde movement. The object of increasing the size of the Cleveland furnaces was two-fold; first, to increase the make, and, secondly, to economise fuel; a third has followed gratuitously, namely, improvement in quality. The author believes that not much has been got from the first consideration; the saving in fuel, however, has been considerable, and may be put down at from 7 to 8 cwt. of coke per ton of iron made. The quality of the iron is also much improved, being more highly carbonised and more uniformly soft throughout than it originally was. A great diversity of internal shapes exists in the Cleveland furnaces, but this is owing to each firm having been left to carry out their own ideas, and being unable to profit by the experience of their neighbours. In concluding this part of his paper the author observed that more settled ideas now prevailed with respect to the sizes of blast furnaces, and it is seen that mere cubic capacity is a mistake, as it is only in those furnaces where proper regard has been paid to the proportions and distribution of the materials charged, that the benefits from the increased size have been fully realised.

The author commenced the descriptive part of his paper by stating that the Ayresome Iron Works are built upon 32 acres of land, with a frontage to the river Tees of 330 yards. There are four furnaces, two of which have been in blast since the end of March this year: the second pair are expected to be ready for blowing in during the spring of next year. The whole of the minerals as they arrive are placed in the standage sidings, and are taken from that place by a four-wheeled tank engine as required, over a 25 ton weighbridge, from thence they descend by the force of gravity to the lift; they are raised by a pneumatic hoist to the top of the depôts, and afterwards tipped into the kilns and boxes respectively. The ironstone is calcined by a proportion of about one in twenty-five of small coal; this as well as the coke is filled into iron barrows, and after being weighed is sent up to the top, four barrows at a time, by the pneumatic lift. Each barrow carries 5 cwt. of coke, and from 12 to 13 cwt. of ironstone, the furnace charge being 8 barrows of coke, 8 of ironstone, and 4 of limestone. The furnaces are closed with the cup and cone arrangement, the gas being carried by down-comer tubes into a culvert below ground from whence it is distributed to the stoves and boilers. There are ten boilers of the plain cylindrical egg-ended shape 60 ft. long and 4 ft. 6 in. in diameter. The three engines are of the direct acting vertical self-contained class, two of which are capable of blowing the four furnaces.

Connected with the works is a wharf now building, which will have a frontage of 210 ft., and on it will be two 4-ton travelling steam cranes. There are also the necessary repairing shops, consisting of smiths', joiners', and fitting shops, with engine shed, store room, offices, &c. The furnaces are entirely built of fire-brick, the pillars and outer casing being built of common size inferior fire-brick, and the lining of best fire-brick, in lumps, 24 in. long by 6 in. thick. The height of the furnaces is 85 ft. At the widest part they are 25 ft., and the hearth is 8 ft. by 3 ft. deep. Each furnace is blown with three tuyeres fixed in water plates in each breast, and the lower part of the hearth is surrounded with water-boxes, bolted together. The author then proceeded to describe in detail the arrangement of the cast-iron pipe stove, introduced by himself at this and other works; the calcining kiln, also devised by him, and extensively used in many iron works; likewise his furnace hoist on the pneumatic principle; concluding with a description of the boilers and a very fine set of blowing engines, which were built by Messrs. Cochrane, Grove, and Company, of Middlesbrough.

* Abstract of paper read before the Iron and Steel Institute.

HOT BLAST STOVES.

*Further Results from the Use of Hot Blast Fire Brick Stoves.**

By MR. THOMAS WHITWELL, Thornaby Iron Works, Stockton.

THE writer commenced by stating that the present paper was a kind of supplement to that read before the Institute some time ago, wherein a description of the stoves as put up at the Consett Iron Works was given. The results submitted in this article are those of the continued working of the apparatus, extending, the one over a course of 2½, and the other over 1½ years. In the previous communication, it had been stated that the stoves were applied to a furnace 55 ft. in height, 20 ft. bosh, 15 ft. 6 in. diameter below charging plate, and 8 ft. hearth; that the average heat, as proved by Messrs. Charles Cochrane and E. A. Cowper, was upwards of 1400° at the tuyeres; that the mineral charged consisted of one-third hematite, and two-thirds Cleveland, a mixture containing 48 per cent. of metallic iron; that the consumption of coke per ton of iron during the first year was 17 cwt. 3 qrs. (weekly make per furnace, 380 tons); that the quality was grey forge, and that the proportion of white iron was only 2 per cent. over the year. The author then referred to a series of papers communicated to the Institute by Mr. I. Lowthian Bell, one of which treated of the results of the working of the furnaces at Consett, wherein he remarked that the increased heat supplied in the blast had been followed by an increased consumption of coke, and the analysis of the gases at the top of the furnace showing more carbonic acid, and less carbonic oxide. Mr. Bell deduced therefrom that the result must have been produced by the heat of the blast only. That gentleman suggested to the company that the heats should be reduced.

Mr. Whitwell next referred to the relative sections of the blast furnaces, working with the fire-brick stoves. No. 4 furnace was blown in during February, 1869, and the averages commenced six weeks after—viz., on April 10th. The pressure of blast at first was 2½ lb., and during the year was increased

* Abstract of paper read before the Iron and Steel Institute.

to 3 lb. per inch, when the temperature was about 1400°, and the average consumption 17 cwt. 5 qrs. per ton of iron produced, the total make being 373 tons per week. During the latter half year the make rose to 401 tons per week, and the coke fell to 17 cwt. 2 qrs., the quality of iron being 84 per cent., No. 4 grey forge. During the next three months there was a little hanging, and some forge slag being put into this the average make per week gave 363 tons with 18 cwt. 0 qrs. 3 lb. coke used per ton of iron. The blowing power was then improved, a higher pressure of blast tried, and the furnace was put on the old burden of one-third hematite and two-thirds Cleveland. There was then noticed an increase in production. When, however, the pressure was raised 60 lb., per square inch, or 40 per cent. the production showed a corresponding increase, but the stoves being already worked to their full power were not able to develop the same temperature, and hence when the pressure of blast was raised to 4 lb. at the beginning of the present year, the production of pig increased 45 per cent., but the consumption of coke with the decrease of temperature to 1200° had risen to 19 cwt. 2 qrs., which increase represents a money value of nearly 1s. 8d. per ton of iron based on the price of coke in the Middlesbrough district. The out-put is now 510 tons per week, being 91 per cent. grey, 9 per cent. mottled, and a trace of white pig. The largest quantity turned out in one week was 587 tons.

The writer next referred to No. 5 furnace, which is different from the one above mentioned in so far as though the same height it is 22 ft. 6 in. diameter at the bosh, and 20 ft. 6 in. below the charging plate. Four fire-brick stoves, with an increase of 17 per cent. in heating surface were applied, and on first blowing in, the heats were 50 per cent. higher than in the case of No. 4, and more regular. About 14 cwt. more coke was used when the blast was at 1400° and about 25 per cent. of white pig was made. This furnace has made all qualities of pig with a mixture of one-third hematite and two-thirds Cleveland iron No. 1 to white, but the production of white without any visible cause has continued. With the heat and pressure of the blast perfectly regulated the author thought that the production of pig iron should have been regular also, but such not being the case, he considered this question very minutely. He had traced the irregularity of yield to the charging, but other iron masters had considered there was no fault to be found with that or the shape of the furnace. The make average 503 tons per week for the first three months with coke 19 cwt. 2 qrs. 8 lb. per ton. Early in the current year the temperature was reduced to 1250° as advised by Mr. I. Lowthian Bell, so as to compare with No. 4 on equal temperatures, but the coke went up to 21 cwt. 2 qrs. being an increase of 2 cwt. for 200° of temperature. The irregularity continued, and the nozzles were enlarged to 64 square inches of area, but without remedying the defect; in fact the production is 60 tons per week less than No. 4, and that at an increase of 2 cwt. of coke per ton of iron turned out. The Consett Company are about to reduce the diameter of the upper part to that of No. 4, as the present dimensions, though they may suit an 80 ft. furnace, will not do for a 55 ft. one, with the mixture named. The writer thinks that in the case of No. 5 the coke and larger pieces of the charge roll to the centre, the small mine and ore remaining near the periphery of the furnace, the blast forces its way up the line of least resistance, viz., the centre.

The Consett Company decided to apply the stove to two new blast furnaces, the size adopted being the mean between 4 and 5, viz., 21 ft. bosh, angle 72°, size under bell 18 ft., 6 in. diameter of bell 11 ft., with a view of arriving at the maximum economy by experiment. One of these furnaces has been in blast about two months, and so far the consumption of coke promises to be the mean between the quantity used in 4 and 5.

The author attributes the successful working of No. 4 to the action of the brickwork in the stoves, which form an actual practice large reservoirs of calorie at a temperature of 1400°, this heat being given off when a stand takes place at tapping time, a "tuyering" or a "scaffold," when in all cast-iron plant, no gas being produced, the stoves are being cooled down, an effect prejudicial to the working of the furnace. The fire brick stoves being always bright red, throw the blast hot into the furnace when it is most needed. These stoves differ from the Siemens system, where all the air is admitted at one point and where a heat for a short time of 1800° has been obtained, in so far as the heated air is admitted among the gas at several points. In conclusion the writer gave the following in his deductions from the above results: 1. That the increase in production in the furnace No. 4 at Consett is directly in proportion to the increase in the amount of blast thrown into the furnace and not consequent on the reduction of temperature. 2. That other things such as the action of materials in the charging and form of furnace being equal, regularity of quality in the iron is in no degree incompatible with a high degree of temperature in the blast. 3. That in the two furnaces at Consett, although there is a great difference in the internal form and capacity, yet no reduction of temperature of the blast has been attended with economy, but that in both cases a reduction of 200° in its temperature has been accompanied by an increase of upwards of 2 cwt. in the consumption of coke per ton of pig iron produced.

THE HEIGHT OF BLAST FURNACES.

*On the Advantage of Increased Height of the Blast Furnaces in the Midland District.**

By Mr. T. W. PLUM, Shifnal, Salop.

THE author stated that this paper had in a certain degree grown out of the discussion on the Ferrie furnaces at the last meeting in London. In the course of that discussion it was contended that the very large proportion of the saving of fuel was due to the increased height of the furnace, and that no additional advantage was gained by the cross walls. It was, however, at the same time, suggested that these latter were calculated to answer an important purpose, in relieving the weight that, in an open furnace, is imposed upon the materials, and this high furnace could be used in districts where the fuel is too tender to bear a considerably increased weight. From certain facts which Mr. Plum gave in detail, he concluded that the novel and peculiar construction of the Ferrie furnace has more to recommend it than at first sight appears, and that the advantages it promises to realise are well worthy of close investigation by the institute. Passing on to consider the example of the Cleveland iron-masters in increasing the height of the blast furnace he pointed out that this plan has not been very extensively followed out in other localities, and it is still a question in the minds of some gentlemen of great experience, whether so much of the saving of fuel attributed, is really due to the greater height. He had information of South Staffordshire furnaces working with a yield as low as 28 cwt. of coal to the ton of iron made, though he informed the meeting that this statement should be accepted with reserve, as the Staffordshire method of reckoning weight is a very lax one. The author next went on to detail certain improvements that seemed to have added so much to the prosperity of the northern ironworks, and which he had endeavoured to engraft upon an old and dilapidated plant in Shropshire, but the different arrangements in form and condition of the old ironworks, and the diversity in the nature of the materials made it necessary to proceed with much care in reconstructing or in adapting the old furnaces to new modes of working. The Old Park Company's furnaces, four in number, were 45 ft. high and 14 ft. 6 in. at the bosh. A portion of the gas was taken from two of these by Darby bells, and utilised for raising steam only. In 1869 it was decided to erect one new furnace, in the place of an old one, to be of the same height, but of more modern construction, viz., cased with iron plates upon twelve iron standards, 6 ft. 6 in., close hearth, six tuyeres equally divided, with provision for a portion of the gas to be taken off by a culvert round the neck of the furnace. The size at bosh was 14 ft. 9 in. While in progress it was determined to make a trial of an increased height of 15 ft., making the furnace 60 ft. high, and it was so finished and got to work, but at present the results obtained from it have not been complete, in consequence of both the heat and pillar of blast not having been as yet so much nor so uniform as required for testing its capabilities; but comparing its work with the other furnaces, so far as it has been practicable to do, the best result has been a yield of about 10 cwt. of coal per ton of iron less than the best on record in the old furnaces. The quality of the metal has been better, and always greyer than indicated by the cinder, usually the reverse of the old furnaces. The favourable comparison obtained from the higher furnace led to the idea of raising one of the old ones to the same height (while working) by putting on an outside casing to the tunnel head, leaving the gas to be taken off about 20 ft. from the top. At first there was no provision for utilising the gas, and the furnace worked extremely hot at the top, and the yield was excessive. It was somewhat improved after the gas was partially withdrawn, but until recently this furnace has not been fairly comparable with the others. From the experience thus gained the author arrived at the following conclusions:—1. That an improved yield has been decidedly obtained from the increased height of the furnace described. 2. That to the extent of 60 ft. it may be safe to construct furnaces in districts having tender cokes to smelt with, but certainly not more, unless upon the Ferrie system, if found to answer the purpose of adequately relieving the materials from undue pressure, as well as of improving the yield, for which the experience in Scotland will doubtless be resorted to for guidance.

* Abstract of paper read before the Iron and Steel Institute.

GASES FROM THE BESSEMER CONVERTER.

*On the Composition of the Gases Evolved from the Bessemer Converter during the Blow.**

By Mr. C. J. SNELUS, A.R.S.M.

THIS investigation was undertaken in the hope of solving some of the difficulties connected with the spectroscopic observation of the Bessemer flame, and also has likely to afford a further insight into the nature of the process going on in the converter.

The gas was collected for analysis by means of an iron gas-pipe, having a swan-necked trumpet mouthpiece of fireclay, which was dipped into the mouth of the vessel after it had been turned up. The gas, from its pressure in the converter, rushed through the pipe with some velocity, and after the whole of the air had been swept out, glass tubes were attached, and when filled with gas, at particular periods of the blow, were hermetically sealed up with the blow-pipe before removal.

The gas was analysed in some cases by two different methods, and the duplicate results were found to agree.

The following tabular statement shows the composition of the gas at different periods of a blow lasting eighteen minutes:

	No. 1 Taken from start	No. 2 4.	No. 3 6.	No. 4 10.	No. 5 12.	No 6 14.
Carbonic acid	10.71	8.57	8.2	3.88	2.3	1.34
Carbonic oxide	None	3.93	4.52	10.59	12.3	11.11
Oxygen ...	.92	——	Absent	Absent	None	None
Hydrogen }	.28	2.00	2.00	2.16	2.00
Nitrogen }	88.37	86.58	85.28	74.89	68.24	65.55
Hydrocarbons					None	
	100.00	100.60	100.00	100.00	100.00	100.00

On dissecting these results we find that the oxygen corresponding to the nitrogen in No. 1 is sufficient to oxidise not only the 4.43 parts by weight of carbon that are contained in the gas, but also 11.91 parts of silicon, and as these two bodies are practically the only ones being burnt from English Bessemer iron at this period of the blow we may take it that these are actually the proportions in which carbon and silicon are now being got rid of from the metal. And this is exactly what analyses of the metal at this stage show, for it was found in one instance that metal containing 3.57 parts carbon and 2.26 silicon at the commencement lost .53 parts of carbon against 1.905 parts of silicon in the first few minutes. Analyses of the gas from another blow about the same time made by W. Thorp, F.C.S., of the Rivers' Commission Laboratory, show practically the same results. Sample three shows that 5.27 parts of carbon are being burnt along with 11.74 parts silicon. Sample four was taken after the commencement of the "boil" when the complete carbon specimen had become permanent. It shows quite a different result from the previous analysis, the large percentage of carbonic oxide now present explaining why the flame has become so much more luminous. We now find that 9.6 parts of carbon are being oxidised along with 6.25 parts of silicon. Sample five was tested specially for hydrocarbons, but none were found. Sample six shows that 13.45 parts of carbon are being burnt at this period, and only .46 parts of silicon which corresponds with analysis of the metal, these proving that the last traces of silicon go off very slowly.

The author considers that the reason why carbonic acid is formed during the first part of the blow, and carbonic oxide at a later stage is to be found in the increase of temperature during the blow. This agrees with experiments of Mr. Bell, who proved that at a low temperature carbonic acid was more stable than carbonic oxide in contact with iron, but that at a high temperature the reverse was the case. It also agrees with general observations. As a general result the comparison of the gas analyses with spectroscopic observations, shows that the reason why we get a continuous spectrum at the commencement of the blow is that we have then only white hot solid matter to look at, there being no actual flame, and the temperature being too low to give the specimen of carbonic acid, while later in the blow we have an abundance of carbonic oxide burning at the mouth of the vessel, which is also at a very high temperature, and, therefore, we get a carbon spectrum which is distinct from other carbon spectra yet seen because we have not yet been able to examine the spectrum of carbonic oxide at the particular temperature of the Bessemer flame. Mr. Snelus believes that Deville's theory of the increased luminosity of flames under great pressure being due solely to the increase of temperature is applicable to the great luminosity of the Bessemer flame compared with that of carbonic oxide burning at a low temperature. On comparing the gas from the Bessemer converter during the latter part of the blow with blast furnace gas, and with analyses of gas from Siemen's producers given by the writer, it is seen that the former is as valuable a fuel in any of them, and as a works using 1000 tons of pig per week is sending this gas to waste at the rate of an equivalent of 25 tons of coke per week, its economical application becomes a point of great importance.

The writer believes this could be accomplished in a simple manner.

* Abstract of paper read before the Iron and Steel Institute.

FERRIE'S BLAST FURNACE.

*On Mr. Ferrie's Self-Coking Blast Furnace.**

By MR. I. LOWTHIAN BELL.

THE author stated that, at the annual meeting of the Iron and Steel Institute, held in March, Mr. Ferrie described the construction of his furnace, and at the same time furnished an account of the ordinary work of this furnace, compared with the results obtained in one of the furnaces of the Coltness Iron Company, working in the ordinary way. The advantage to be derived from the increased height of furnaces having been demonstrated in the North of England, it was natural to inquire how much of the economy obtained by Mr. Ferrie was due to the increase of height, and how much to the heat evolved by the combustion of a portion of the furnace gases in the flues. Mr. Bell stated at the previous meeting that whether the fuel used in the furnace were employed in the shape of coke or coal, it was not until it had assumed the former condition that its real work in smelting began, and he pointed out that, viewing the process in this manner, it appeared to him somewhat doubtful whether the advantage of Mr. Ferrie's system was not chiefly due to the addition made to the height of the furnace, rather than to the self-coking portion of the charge. He was led to entertain this opinion from the fact that, taking the quantity of coke in the coal actually used by Mr. Ferrie, it corresponded, after making the necessary allowance for his richer stone, with the fuel used by the author's firm, where the coal is used in its coked state. Within the last month, the writer had been engaged in a series of estimates, in order to ascertain the precise nature of the heat evolution and appropriation in furnaces where the coal is used in its raw state, and these experiments have induced him to think that he was mistaken in the opinions expressed during the discussion upon Mr. Ferrie's paper. The author proceeded to demonstrate, with much minuteness, the precise amount of saving that is effected in the Ferrie furnace, and he came to the conclusion that half the saving of coal is due to the increase of height, and half to the combustion of the gases in the flues in the upper portion of the furnace. In this examination he confined himself entirely to an estimate of the actual evolution and appropriation of heat, but as he was informed that all previous attempts to economise fuel in Scotland by means of higher furnaces than those in general use at the present day failed, it is possible that the intervention of the structure forming the upper part of the coking furnace may be useful in the manner alluded to by Mr. Plum, by relieving a tender material of a portion of the superincumbent weight. The author also alluded to the statement of Mr. Ferrie, to the effect that in his furnace there was an improved yield from the ironstone. Although the quantity stated by Mr. Ferrie seemed large, the results obtained by comparing Coltness with Monkland appeared conclusive, and, therefore, he agreed with Mr. Ferrie in thinking that the saving at the top of the furnace is the only way to account for the difference in yield mentioned by Mr. Ferrie and confirmed by the Coltness Company.

* Abstract of paper read before the Iron and Steel Institute.

THE ROYAL AGRICULTURAL SOCIETY'S SHOW AT CARDIFF.

As most of our readers are no doubt aware the next meeting of the Royal Agricultural Society is to be held at Cardiff. The programme for this meeting has just been issued and we subjoin those portions of it relating to the trials of engines and machines. The trials we may mention will commence on June 26th and conclude on July 8th next year, while the show itself will be open on July 15th and four following days. All certificates of entry of implements, &c., for exhibition must be in the hands of the secretary of the society on or before the 1st of May next.

Prizes.

Class 1. For the best portable steam engine (not self-moving), not exceeding 8 horse power (two prizes), 40*l.* and 20*l.* *Class* 2. For the best combined portable threshing and finishing machine, to be worked by steam, and adapted to the preparation of corn for market (two prizes), 40*l.* and 20*l.*; *Class* 3. For the best combined portable threshing machine, to be worked by steam, which has no corn screen or other apparatus for sorting the grain for market (two prizes), 40*l.* and 20*l.*; *Class* 4. For the best straw elevator, to be worked by steam in conjunction with a threshing machine (two prizes), 10*l.* and 5*l.*; *Class* 5. For the best straw or hay elevator, to be worked by horse power (two prizes), 10*l.* and 5*l.*; *Class* 6. For the best seed drawer 10*l.* *Class* 7. For the best corn dressing machine (three prizes), 15*l.*, 10*l.*, and 5*l.*; *Class* 8. For the best corn screen (two prizes), 10*l.* 5*l.* Miscellaneous awards to agricultural articles not included in the quinquennial rotation, ten silver medals. In the class for which one prize only is offered, the judges will be empowered to divide it equally between two competing implements, if they consider them equal in merit.

Conditions.

Steam Engines.—All engines must be fitted with a steam indicator, in addition to the ordinary spring balance, which indicator must be proved by the indicator of the society.

Portable Engines:

1. All the general conditions respecting steam engines and boilers will have to be observed.

2. The nominal power of the engines entered for trial will be taken at one-third the indicated power, at 60 lb. pressure in the boiler, cutting off at three-fourths the stroke, and the periphery of the fly-wheel running 1884 ft. per minute.

3. The engines will be tested by the society's friction brake, worked by means of connecting rod and universal joints direct from the crank shaft. Each engine entered will have to be fitted with a clutch, shown in detail in Fig. 4, Form A of Engineers' Instructions, and to facilitate the society's arrangements, the height of the crank shaft of each engine above the ground must be stated when the specification is sent in to the Secretary.

4. The engines will be tested for economy in coal, water, lubrication, and steadiness in running. Indicator diagrams will also be taken, and, therefore, the preparations for receiving the indicators, described in Form A, must be provided.

5. During the trial runs one man only will be allowed to attend the engine. Over or under-running will not be permitted, steady running as nearly as possible at the speed declared at entry will be considered a point of merit. The engines must be fitted with governors, and the efficiency of the latter will be tested after the trials for economy of working are over, by suddenly varying the load on the brake.

6. Exhibitors shall, on making their final specifications, elect at what steam pressure, not exceeding the declared pressure, what horse power on the brake, and what number of revolutions they would wish to be tried.

7. The order in which the several engines will be tested will be determined by the stewards, who will decide by lot.

8. Detached feed water heaters not ordinarily sold with engines, and included in the prices entered, will not be allowed, but heaters permanently fixed to the engines or arrangements for carrying waste steam to the water tanks, provided they are included in the price of the engine, will be admitted.

9. The trials of the steam engines will be made with Llangennech coal.

Threshing Machines:

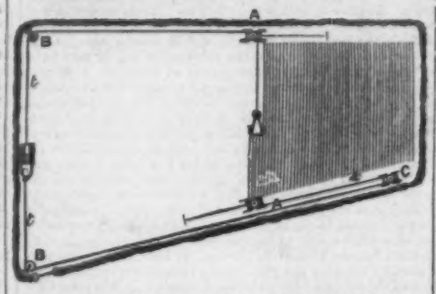
10. The threshing machines will be driven by a portable engine through a registering dynamometer, both provided by the society. The driving pulleys on the machines must be adapted to 1884 ft. per minute speed of driving belt.

11. The merits of the machines will depend upon the price, economy of power and time; the marks obtained for clean threshing, clean shaking, freedom from cavings, freedom of chaff from corn, from cavings and from seeds, unbroken straw, uninjured corn, cleanness of delivery from the machine, and perfection of finishing in Class 2. The points representing perfection will be as under:

Clean threshing	150
Clean shaking	40
Freedom from cavings	80
Chaff free from corn	50
Chaff free from cavings	20
Chaff free from seeds	40
Straw unbroken	20
Corn uninjured	70
Cleanness of delivery from machine, i.e., absence of lodgment in screens, &c.	10
Perfection of finishing, that is screening or sorting in Class III. only	20
	450

12. The sheaves to be threshed will be kept under cover, the stacks will be worked down vertically so as to give each machine as nearly as possible the same quality of work, the sheaves will be served out by weight to each machine. The straw resulting will be re-threshed, and the various products delivered by the machines, as well as the corn separated by the second threshing, will be carefully weighed and samples set apart for final comparison.

BENNETT'S SYSTEM OF STEAM CULTIVATION.



13. Means must be provided for examining the inside of the machines as perfectly as possible, in order to ascertain how completely the various products are delivered, it will be a point of merit in a machine to empty itself completely and leave no lodgments in the screens, &c.

14. Those machines which appear to the judges of sufficient merit, will be run for a prolonged trial, in order to enable a more correct and satisfactory judgment of their merits to be arrived at.

Classes IV.—VIII.

15. The machines in Classes IV., V., VI., VII., and VIII., will be judged chiefly with reference to the manner in which they perform their work, to the goodness of design and workmanship, and to their cost. Dynamometers will be used whenever the judges think it advisable to determine the amount of power necessary to drive the machines.

General Regulations Respecting Steam Engines and Boilers.

There will be no restriction as to the construction of steam engines or boilers, except that the pressure of steam shall not exceed 80 lb., and the engineers of the society must be satisfied that the bursting strength of the engine or boiler is at least four times its working pressure, and that a hydraulic test of one and a half times the working pressure has been satisfactorily applied.

Each exhibitor, on sending in his specification, must declare the greatest pressure at which he proposes to work his boiler or engine.

No old boilers—that is, boilers that have manifestly been at work for a considerable time—will be admitted without special thorough examination and a certificate of safety from the society's engineers.

Each boiler of whatever form or size must be provided with the following mountings:

Two safety valves, each of sufficient size to let off all the steam the boiler can generate without allowing the pressure to rise 10 per cent. above the pressure to which the valve is set.

Two sets of gauges for ascertaining the water level.

One steam pressure gauge, which must be tested and verified by the society's engineers before the boiler can be used.

A ½ in. cock, terminating in a ½ in. male gas thread for the purpose of receiving the society's testing pump.

One check feed valve, immediately attached to the boiler, in addition to the ordinary pump valves, whenever the feed is introduced below the lowest safe water level or where there is a length of feed pipe between the engine and boiler.

No boiler or engine will be allowed to work without having the engineers' certificate of safety, and the limit of pressure conspicuously attached to it.

Any engine which is entered for competition, or for working in the yard of "Machinery in Motion," which, from defect in construction, or any other cause, is, in the opinion of the judges and consulting engineer, "unsafe," shall not be allowed to work on the society's premises; and further, the word "unsafe" shall be attached to the engine during the remainder of the exhibition.

In competitive trials before the judges, Llangennech coal, provided by the society, will be used. In the show yard, exhibitors must find their own coal; it must be consumed without the production of smoke, and efficient spark catchers must be fitted to the chimneys.

Water for the supply of the steam boilers will be provided by the society.

Exhibitors must be provided with all the appliances necessary for taking the working parts of the machinery to pieces, for examination, should the judges or engineers require it.

STEAM CULTIVATION.

We give, above, engravings illustrating a system of steam cultivation designed by Mr. H. Ogilvie Bennett, of the firm of Messrs. Bennett and Kennedy, of Edinburgh. This system, when in operation, consists of a traction engine, or farm locomotive, which, by running to and fro along the side, or any convenient part of the field to be cultivated, or on an adjoining field or road, draws any description of implement from side to side of the field, by transmitting its motion through a rope passing round guide pulleys or anchors placed at convenient points to suit circumstances, some of such guide pulleys or anchors being self-shifting. The ground plan clearly shows the arrangement. The self-shifting guide pulleys or anchors, A A, are disposed so as to be moved along the headlands at intervals as the operation proceeds, the stationary guide pulleys, B, being placed so as to conduct the rope in the most convenient manner to and from the engine to the implements or carriage. The ploughing or other implements are drawn in the line across from one self-shifting pulley to the other, and the engine moves to and fro on the track or road, *t t*. The simple onward movement of the implement is obtained by the engine traversing over a distance corresponding to that traversed by the implement, but in a different direction. *C* is a self-shifting pulley, provided to regulate the length of rope by taking up slack or giving more length; this will only be necessary where the field is not rectangular.

The advantages claimed by Mr. Bennett, for this system are: The application of the best form of engine for road traction purposes, to cultivation, or the drawing of wheeled carriages or wagons across fields, so that a farmer requiring a traction engine may, with the best engine to be had for this work, cultivate his farm at favourable times. The engines can remove the anchors, &c., from field to field, and by travelling round the field leave them in their places ready for work, and can also draw the rope round the field. It is also urged that the system can be quickly set in operation, as the rope is merely fastened to both ends of the engine by clip links, which are easily attached or cast loose, while no windlass is required. It is considered that at most three men and two boys are sufficient; only one engineer, and he may be kept in constant employment with the engine; the other men and boys need only be agricultural labourers.

The engine, it will be noticed, does not pass over the ground to be cultivated, or that has been cultivated, but, on the contrary, it moves to and fro over any convenient line of ground or road, while the implement or carriage is gradually working up the field. Where a road adjoins any side of the field, the engine is run on this road, and not on the field. Mr. Bennett considers that even where soft at first, the track on which the engine travels is, after a few turns of the engine, rolled hard, and is therefore less easily affected by rain. When this track is too wet for the engine, the rope may at once be cast off, and the engine sent to perform traction or stationary work, or if the track be covered with a layer of ashes, the work may be continued in wet weather. In many cases hard roads adjoin fields, and these are, of course, used in preference to the headlands.

In conclusion we may state that Mr. Bennett's system appears to be intended rather as a plan for enabling traction engines in the possession of farmers to be turned to account for steam cultivating purposes by a moderate outlay, than as a system which it is proposed to place in competition with ploughing tackle on the clip drum, double drum, or double-engine systems.

BOILERS AT MESSRS. GILKES, WILSON, PEASE, AND CO., TEES IRON WORKS, MIDDLESBROUGH.

CONSTRUCTED FROM THE DESIGNS OF MR. CHARLES WOOD, ENGINEER.

FIG 4.

We publish this week, on the present page and page 142, engravings of three of a set of boilers erected by Messrs. Gilkes, Wilson, Pease, and Co., at their works—the Tees Iron Works, Middlesbrough—about a year ago. The boilers are five in number, but only four are in use at one time. They are employed to make steam for two blowing engines as well as for working the furnace and calcining kiln lifts, and they are worked in connexion with two large blast furnaces, each 85 ft. high and 27 ft. in diameter at the boshes, being designed specially for being heated by the blast furnace gases.

Referring to the engravings, it will be seen that the boilers are of the "elephant" type; but they differ materially from "elephant" boilers as ordinarily constructed. Elephant boilers are open to the objection of there being a defective circulation in the lower tubes, thus causing the latter to be liable to be burned away when exposed to a strong heat. In the boilers we are describing, however, special care has been taken to avoid the above defect, while the boilers have also been designed with a view of obtaining abundant heating surface in a compact form, and of making provision for the thorough combustion of the gases at the front or firebox end.

Each boiler consists of an upper barrel, 44 ft. long by 4 ft. 6 in. diameter, and two lower tubes, each 20 in. in diameter, these lower tubes being each united to the barrel by six connecting tubes, each 15 in. in diameter, in addition to being itself curved upwards at one end to join the main barrel, as shown in the longitudinal section on page 142. The lower tubes, it will be noticed, are slightly inclined, each rising towards the firebox end, while the connecting tubes are each fitted with an internal circulating tube, which serves to separate the descending current of water from the rising current of steam. The form of these internal circulating pipes, and the mode of fixing them, are clearly shown in our engravings. The inclination of the lower tubes together with the large combined area of the connecting tubes, render the circulation in the lower tubes very efficient, and we are informed, in fact, that the lower tubes, and particularly those parts at the firebox end, are kept perfectly clean, the deposits taking place at the hind end, where the lower tubes are extended backwards beyond the line of the connecting tubes, as shown in the longitudinal section and plan. These hind portions of the lower tubes being out of the circulating current, serve as mud-catchers, and to them are attached the blow-off cocks, as shown. The practice is to blow off the mud every twelve hours. The ends of the lower tubes are made to take off for cleaning; but this is seldom necessary, there being, as we have said, little deposit except in those portions extending at the hind end beyond the connecting tubes.

Referring to the longitudinal section and plan it will be seen that a large combustion chamber is provided at the firebox end, so as to obtain a good admixture of the gases and air and insure the complete combustion of the former at the front end, the flame seldom extending beyond the first bridge. From sight holes in the cleaning doors by the sludge pipes a view can be obtained right along the bottom of the boilers, and if it is found that the latter are not making enough steam, air is admitted in front until such time as the flame ceases to be visible from these sight holes. When this is done the steam will rise rapidly, the maintenance of an abundant supply of steam being a matter of perfect combustion only. When clean, during the first week, these boilers evaporate about 600 gallons per hour; four boilers being as we have said kept at work while one is laid off every week.

The manner in which the boilers are set will be readily understood from our engravings. They are, as will be seen, each suspended from three cross girders, in a plain flue with three bridges, the products of combustion only passing once along the length of each boiler, and being

then led off to a chimney by a descending flue fitted with a sliding damper, as shown. The gases from the blast furnace are brought to the boilers by a flue beneath the ground level at the front end, as shown in the longitudinal section, gas mains, arranged as shown in the various views, conducting the gases from the flue to the combustion chambers. The longitudinal section and front elevation also show the construction of the nozzles at which the gases are burnt. The combustion chambers are all fitted with ordinary firegrates, for use if required, the mouths of the ashpits being, of course, however, under ordinary circumstances, closed airtight. Each boiler is provided with a steam dome, two safety valves, and all the necessary fittings, and the whole arrangement and details are very neatly worked out. In conclusion, we should state that the boilers have been made from the designs, and under the direction, of Mr. Charles Wood, the engineer to the Tees Iron Works.

DANKS'S PUDDLING FURNACE.

*A Description of Danks's Patent Revolving Puddling Furnace.**

By MR. SAMUEL DANKS, of Cincinnati, Ohio, U.S.A.

THE author stated that experiments were commenced in the Cincinnati Railway Iron Works, in May, 1868, with a small revolving furnace to puddle from 250 to 300 lb. per heat. Successful results being obtained, two larger furnaces were built, and were got to work in April, 1869, since which period they have continued in regular operation, and are now at work. Several improvements have, however, from time to time, been made in them and adopted. In April, 1870, the above company, finding that the work and results obtained were so satisfactory, ordered the removal of all their old hand puddling furnaces as fast as the revolving ones could be erected. They are now puddling exclusively with the machine puddlers, and are making puddled balls 700 lb. in weight. In February, 1871, the Roane Iron Company, at Chattanooga, Tennessee, commenced working a 700 lb. furnace, and contracted for ten more. Particulars were given by the author of the various works in the United States, where the revolving puddling furnace has been adopted, among which are the Ohio Falls Co., New Albany, Indiana, the Jones and Langlin Works, Pittsburgh, Pa., Akins Brothers' Works, Pottsville, Pa., the Indianapolis Rail Mill Co., and the Atalanta Rolling Mill Co., Georgia; and at all these establishments it is asserted that the machine has worked very satisfactorily.

The furnace has a firegrate in outward appearance like the ordinary puddling furnace, but it differs from this considerably in several particulars. It is supplied with a fan blast under the grate to urge the fire and produce gas. It has also jets of fan blast over the fire injected for the purpose of insuring the more perfect combustion of the fuel. This blast is regulated by a valve, by which the workman has a perfect control of the quantity of gas generated and consumed, and is thus enabled to make the temperature suit the requirements of the charge in the different stages of the puddling process. The ashpit and firehole are closed by doors to prevent the escape of the blast except through the fire, and the firehole has a coil of wrought-iron water-pipe cast into it for the purpose of allowing a stream of water to circulate around it to keep it cool. A similar coil is inserted in the bridge plate between the fire and a charge of metal. Fastened on to the bridge-plate is a ring with a flat surface on one side, which ring has a pipe or pipes cast into it, and is made in one piece, or in sections. This forms a butt joint with the revolving part of the furnace. The face is cast on a metal chill to harden the part exposed to abrasion from the end of the revolving chamber rubbing against it.

The revolving chamber is made of two end pieces, so formed as to be banded together with wrought-iron bands, and to have detachable rings on the part most exposed to the fire. It rests on carrying rollers to allow its free rotation, and has also suitable ribs for strengthening it, with holes for rivetting the rings and stave plates upon it. The two ends are connected together by a series of stave plates to form a cylinder, and are of suitable length, according to the desired size of the chamber. They have hollow ribs running longitudinally, which serve the double purpose of holding the fettling, and keeping it cool, and, when rivetted together, form an open-ended cylinder, one end of which butts against the ring that is fastened to the bridge plate, where the gases are admitted over the bridge from the grate, and the other open end serves the purpose of a doorway for the reception of the charges of iron, and also for their removal, as well as for the escape of the products of combustion through a movable headpiece, which connects the revolving chamber and the chimney. This piece can be moved at pleasure by means of a suitable apparatus overhead, and, when in its place for puddling, the escaping gases pass through it into the stationary flue, and thence to the chimney or boiler. When adjusted for puddling, the piece is held in position by suitable props, and balls of great weight can be removed from the furnace very readily, the end being open. It has also an arrangement of water pipes for keeping it cool, and a stopper hole in front, so that the operations going on inside can be seen at all times.

The vessel is made to revolve by means of a toothed wheel fixed longitudinally upon it. A suitable engine is attached to each machine so that the chamber can be made to revolve at any speed that may be required according to the different stages of the operation. The most important feature in connexion with the invention is the lining of the vessel. The foundation consists of what is termed the "initial" lining, which is composed of a mixture of pulverised iron ore and pure lime, worked with water into the consistency of a thick paste. The method of putting on this "initial" lining is fully described, and when completed the author says that upon it is placed the fettling proper. A quantity of pulverised iron ore about one-fifth of the total amount required to fettle the apparatus is thrown in, the furnace is heated and made to revolve slowly until the iron is found to be completely melted, and the apparatus is then stopped. That part of the molten iron which has not been consumed by glazing the "initial" lining surface runs to the lowest level of the furnace, and there forms a pool, into which there are put a number of small and large lumps of iron ore of such dimensions as will be required to allow the said lumps to project over the surface of the liquid ore by from two to six inches. This part of the fettling is allowed to set when a fresh quantity of pulverised ore is thrown in. The furnace is again made to rotate slightly until the newly added ore is liquefied, when the apparatus is again stopped, and the pool is filled with lumps as before. The operation is continued in this way until the whole of the vessel is properly fettled. From 2 to 2½ tons of iron ore are required to fettle a 700 lb. furnace. The iron is charged into the furnace either in a solid or molten condition. When charged in the shape of pig iron, the melting down occupies from 30 to 35 minutes, during which a partial rotation is given to the furnace from time to time, in order to expose equally all sides of the charge to the flame. When the whole of this is thoroughly melted, the furnace is made to rotate once or twice per minute only during the first five or ten minutes, in order to obtain the most perfect action of the cinder upon the molten iron. A stream of water is injected through the stopper hole along and just above the line of contact between the floating cinder and the inner surface of the vessel on the descending side. A certain portion of uncontaminated cinder is thereby solidified on the metal surface, and is carried down into or below the bath of molten iron in a continuous stream, which, in rising up through the iron, combines with the impurities of the latter in a far more effectual and complete manner than any mode of puddling hitherto known can effect. On the expiration of the said five or ten minutes, the iron begins to thicken, and the motion is stopped. The heat is then raised so that the cinder shall be perfectly liquefied, and the vessel is brought into such a position that the tap hole shall be just over the level of the iron, which by this time has become partly pasty. The puddler gently pushes back the iron and the cinder is made to run off. The heat is again raised, and the furnace is put in motion at a velocity of from six to eight revolutions per minute, by which means the charge is dashed about violently in the furnace. A high temperature being kept up, and the charge being continually turned over, the particles begin to adhere, when the velocity of the apparatus is lowered to from two to three revolutions per minute, upon which the ball then very speedily forms. The puddler then solidifies the front end of the ball by a few blows from a tool applied through the stopper hole. The props of the movable piece are then removed, and the flue hanging from the overhead rail is moved away. A large fork suspended from a crane is put into the vessel along one side, and the ball, which by a turn of the vessel is rolled on to the fork, is then taken out by means of a crane. The ball is then worked in a squeezer. The flue is replaced after the requisite quantity of cinder and metal have been again charged, and the process is continued. From eight to ten charges are made before any refettling is required, and these heats are worked in a day of 10 hours. The writer gave results that have been furnished to him, as obtained at different works, by the use of revolving puddling furnaces. The following may be taken as a sample of these: Puddling cold pigs charged at the Cincinnati Railway Works for week ending July 9th, 1871:

	lb.
184 heats, 600 lb. each	110,400
Product of rail tops	116,811
Gain	6,411 lb. or 5.8 per cent.

Time, 5 furnaces 4 days, and 4 furnaces 1 day. A day lost, in consequence of the national holiday, on July 4th. Week ending July 15, 1871:

	lb.
218 heats of cold pig, charged 600 lb. each	130,960
Product (tops)	136,934
	6,134 lb. or 4.68 per cent.

Furnaces at work, 4 for 2 days, 5 for 3, 6 for 1 day. Quality of pig used, half inferior, weak, cheap, and half fair charcoal. Thermometer ranged above 90° during the above period, and most of the ordinary iron working had to be stopped a part of the time. The excess of product over the weight charged is caused by the richness of the fettling used. Mr. Danks claimed for the revolving furnace the following advantages: A great saving in the cost of labour and also in the consumption of coal, varying according to the size of the furnace; a superior and more regular quality of puddled iron from a given quality of pig; a yield of puddled iron much in excess of the charge of pig metal, instead of the usual loss, the extra yield being obtained by the reduction of the rich fettling used in the machine; eight to ten heats, whether of from 5 to 10 cwts. are made in a day of ten hours, when suitable metal is used; the refining process is very complete, the whole of the phosphorus, and silica, and the sulphur, to a large extent, being removed by the chemical action of the lining mixture; the very heavy and exhaustive labour of puddling is performed by steam power, thereby enabling one skilled man to attend to the working of a large quantity of iron; the bringing to nature and balling of the iron is completed by the rotary action, without the use of rabbling, except when the heat has to be divided into smaller balls, and the capacity may be suited for heats of any weight from 5 cwt. upwards. The cost of the furnace, weight of product considered, is about the same as that of the usual hand puddling furnaces.

In order, however, that these advantages may be obtained to their full extent, by the use of this new form of puddling furnace, it is essential that the whole of the arrangements connected with the manipulation of the iron may be upon a suitable scale.

It is almost needless to say that the existing arrangements for hammering and rolling puddled iron would not be suitable, where such large masses of puddled iron have to be dealt with. In proportion as the subsidiary appliances are carried out upon a proper scale, so will be the advantageous results obtained from the puddling apparatus.

As a further evidence of its undisputed success in America, the Great Industrial Exposition, held in Cincinnati, in 1870, awarded a special gold medal to the writer "for his valuable invention," and this award was made after the judges on that class of machines had personally witnessed its great success in doing all that he claims for it, and who were previously sceptical of the possibility of such yield and quality of product, and also of such a saving of material as they saw effected in the furnaces.

In the course of the discussion Mr. Fothergill, M.P., stated that he had seen Mr. Menelaus's puddling machine at Dowlais at work, but he found there were two great practical difficulties in connexion with it. The first was that the fettling was destroyed by the breaking down of the iron, and, secondly, the fettling was so highly silicious that the quality of the iron was completely destroyed. It appeared from what was stated in the paper that Mr. Danks had overcome these difficulties.

Mr. E. Williams (Middlesbrough) did not see any material difference between the machine of Mr. Danks and that of Mr. Menelaus; and it appeared to him that what could be done with the one machine could be done with the other. The lining in both furnaces was thick, and it seemed to him that the point to be aimed at was to get a furnace with a thin lining cooled by water from the outside.

Mr. Kitson urged that the council of the institute should go to the expense of erecting one of Mr. Danks's furnaces, and practically test the benefit claimed for it.

Mr. Menelaus said no one would have rejoiced more than he should if Mr. Danks had really succeeded in overcoming the difficulties which met him in his endeavours to produce puddling by means of machinery. He had been in treaty with Mr. Danks for the erection of one of his machines; but as this involved great expense, they had not yet come to terms, as he (Mr. Menelaus) was anxious the matter should be commercially satisfactory. In order to test the truth of the statements made in the paper, he would suggest that the funds at the disposal of the puddling committee should be expended in sending a commission to America to investigate the subject. If, however, this was not done he and some others were determined to go to the expense of sending such a commission on their own account; but, however the thing was done, the information gained would be equally at the service of the members of the institute.

After some remarks from Mr. Walter Williams, of West Bromwich,

Mr. Danks said that he would give every facility to any commission that might be sent to America to investigate his invention. He then proceeded to give some further details respecting the working of his machine, and to reply to points which had been raised in the course of the discussion.

THE HAGUE AND ROTTERDAM STEAM FIRE ENGINE.—Very satisfactory results have been obtained from these engines built by Messrs. Merryweather and Sons. The engine for the Hague delivered 5 per cent. more water than the quantity stipulated, whilst the performance of the Rotterdam engine exceeded the promised quantity by 50 gallons per minute. It is satisfactory to the English engineering trade in general to give proof that their productions, as in this instance, are rather under-rated in their powers, than in giving out results which they cannot maintain.

THE NEW METROPOLIS WATER ACT.—On Saturday was issued the Act to amend the Metropolis Water Act, 1852, and to make further provision for the due supply of water to the metropolis and certain places in the neighbourhood thereof. There are 51 sections in the Act and three schedules. The object of the statute, as expressed in the preamble, is to make further provision for securing to the metropolis a constant supply of pure and wholesome water. It is with the recited Act (15 and 16 Vic., c. 84) to be construed as one Act. "From and after the passing of this Act (August 21), every company shall on Sundays, as on other days, supply sufficient pure and wholesome water for the domestic use of the inhabitants within their water limits." After eight months from the passing of the Act, every company, when required so to do in the manner directed, is to provide and keep throughout its water limits a constant supply of water for domestic purposes, and make such water reach the top story. After six months from the passing the metropolitan authority may make application for a constant supply within such district, and when not provided an appeal is given to the Board of Trade. There are various regulations set forth in the statute, which are to be published, and penalties to be recovered for non-compliance. The companies may require owners and occupiers to provide proper "fittings," which term includes communication pipes, and also all pipes, cocks, cisterns, &c., used or intended for supply of water by a company to a consumer, and for that purpose placed in or about the premises of the consumer. Power is given to enter premises for the inspection and repair of the fittings. There are provisions as to fire-plugs. The Board of Trade may appoint persons to inquire and report upon the quality of the water. There are various other provisions to carry out the preamble, and there is a section that an incoming tenant is not to pay the arrears of the outgoing tenant unless by express agreement. The schedules annexed to the statute explain the metropolitan authority, the districts, and the companies mentioned in the Act.

* Abstract of paper read before the Iron and Steel Institute. One form of Mr. Danks's furnace was illustrated by us in our last number.

THE NEW YORK CANAL COMMISSION.

THE Commission appointed by law to examine inventions, and apportion the reward of one hundred thousand dollars for improved canal boat propulsion, lately held their first meeting at Albany, N.Y. The Commission consists of Geo. B. MacClellan, Horatio Seymour, Erastus S. Prosser, David Dows, George Geddes, Van R. Richmond, Willis S. Nelson, George W. Chapman, William W. Wright, and John D. Fay. Van R. Richmond was elected chairman, H. A. Petrie, secretary, David M. Greene, engineer. The following resolutions were adopted:

Resolved, That for the purpose of carrying out the intent of the law, this Commission will require, among the tests to be made, that the several competitors shall make not less than three round trips from New York and Buffalo or Oswego, each boat to be loaded with not less than two hundred tons of cargo each way, the trips to be commenced as soon as any party is ready and all completed in the least practicable time. For the purpose of determining the time consumed by each and all the trips, the clearance must show the day of the month and time of day that the boat passes each collector's office; certified copies thereof to be furnished to the Commission. In order to obtain information in regard to the practical working of the several devices in competition, as soon as practicable, the engineer of the Commission, David M. Greene, of Troy, will inspect the same from time to time, as in his judgment may be necessary, and report the facts obtained to this Commission.

Resolved, That competitors are hereby notified that, for the purpose of carrying out the intent of the law, though it is desirable that the three consecutive round trips from Buffalo or Oswego to New York be made at the earliest time practicable, that the whole of the year 1872 will be allowed to such persons as may desire as much time, and that the awards will not be made until the close of navigation in that year.

The next meeting of the Commission was fixed for August 14th, at the office of the Canal Commissioner, Syracuse, N.Y. Persons who desire to communicate with the Commission should address Henry A. Petrie, secretary, office of the State Engineer, Albany, N. Y.

INDIAN ENGINEERING EXAMINATION.

TO THE EDITOR OF ENGINEERING.

SIR,—Having allowed us through your paper to state briefly our grievances in reference to the Indian P. W. D. examination, would it be trespassing too much upon your goodness to ask you to give a short article in your next issue, as there can be no doubt but that we were shamefully treated; many of us poor men were brought up to London when the college authorities well knew that they had not the slightest intention of nominating us; the four passed can only have been appointed as "a blind." Could it have been otherwise? Had twelve or eighteen men passed, the public would immediately inquire for what reason had 120,000*l.* to 150,000*l.* of public money been expended; as it must be remembered that when the idea of a college was mooted in 1870 it was put down by public opinion, in which year, in order to better substantiate the claim for a college only eleven men were allowed to pass; this year the college is established, it is then given out that there will not be another competitive examination, they are again forced to give in, and the late examination was held, at which two out of the three examiners were college professors. Should you not deem it expedient to accede to my wishes, will you kindly insert the following letter, which, considering the number of points, has been made as brief as possible.

Faithfully yours,

GRAHAM SMITH (No. 7), Stud. Inst. C.E.

39, Warwick Gardens, Kensington, August 26, 1871.

TO THE EDITOR OF ENGINEERING.

SIR,—I do not wish to trouble you with a repetition of the letters which have already appeared in your columns under this head, I would only say that all facts stated in these are as true as it is extraordinary that such a mode of conducting an examination should be allowed.

The complaints which I would beg you to give me space for, are:

1st. The way in which the unsuccessful candidates have been treated as to the results of their labours. I am myself one of these. The only communication I received after the examination was to the effect that I was not through.

Now, Sir, the object of an examination, to my mind, is to ascertain the proficiency, in order, of the candidates in the subjects they are examined in, and if it so turns out that but few of them come up to the required standard for the appointments they are competing for, it is to be hoped that the rest may still be fit for something, and therefore their positions in the list ought to be made known to them, so that those who hold good ones may be able to mention the fact in applying for other appointments. This is always done in the Indian Civil Service Examination, and was done in the late Engineering College Examination. It was not done in the late Direct Appointments Examination.

This being the case, I applied to the India Office to know my position. In return, I could only get a copy of my marks, which left me as ignorant as before as to my place; on my writing again for the required information my letter was simply ignored.

This treatment, after I have spent more than three years in preparing for the examination, seems somewhat hard, as one has apparently nothing to show for real hard work, and all engineers of the present day know how difficult it is to obtain employment, and how valuable a good recommendation may prove to a young man in starting in the profession. I do hope this matter will be reconsidered, and each candidate furnished with a list.

2nd. The intention of the Government to give no more chances of appointments in India to the men who have been preparing for these examinations. It should be remembered that our course extends over at least three years, and it is now only one since the college was first talked of.

Surely those who have lately failed, and can prove that they have been looking forward to these examinations, should be allowed to compete with the members of the college without passing the preliminary examination which their age puts out of their power.

"Fair Play is a Jewel," and unless some such arrangement is made, I, for one, shall gather that such is not the motto of the authorities of the India Office.

I am, Sir, your obedient Servant,

J. H.

IRON RAILWAY SLEEPERS.

TO THE EDITOR OF ENGINEERING.

SIR,—In your edition of the 25th of August I notice a characteristic letter from the pen of Mr. Greaves, who, I think, might have contented himself with merely correcting the error you made in crediting my sleeper with a test made upon one of his, and which error might possibly arise from the fact that Messrs. Richardson and Sons are engaged upon a contract for 6000 tons of my sleepers.

With regard to the test by falling weight, I have inspectors' reports, showing tests quite equal to that of Mr. Greaves's sleeper, but consider such results quite exceptional.

I have also noticed that sleepers of small area and light weight give higher results than larger and heavier sleepers.

Mr. Greaves says: "The result was equally unsatisfactory when the engineers for whom they were made had some of them sent up to the testing machine at Lambeth."

Such, however, is not the case. Mr. Edward Woods, C.E., who ordered the testing of these sleepers, desires me to say that he was perfectly satisfied with the result of the testing he witnessed. The first sleeper tested broke at 3 ft., the tup, weighing 3½ cwt., having fallen upon the sleeper seventeen times, commencing at 1 ft., and rising 6 in. after each blow.

But perhaps the best refutation to the uncalled-for statements made Mr. Greaves in your journal and elsewhere, is the fact of the large and increasing adoption of my various systems of permanent way.

During the last few years more than 150,000 tons have been cast for various railways abroad, and at the present moment a number of contracts are in hand, five of which are for extensions of railways already laid with my sleepers.

I am, Sir, yours &c.,

JAMES LIVESEY.

9, Victoria Chambers, Westminster, London, S.W.,
August 31, 1871.

FOREIGN AND COLONIAL NOTES.

Iron in Guayaquil.—Advices from Guayaquil report the discovery of iron in great abundance on the banks of the river Douil. Surrounding forests produce plenty of wood which can be converted into charcoal, and used in working the iron ore.

Surveys in Manitoba.—Mr. Lindsay Russell, C.E., has been appointed inspector of surveys in Manitobe. Mr. Russell has left for the scene of his future duties.

The Merrimac.—The Merrimac river is now in course of improvement at Mitchell's lower falls, about three miles above Haverhill, Massachusetts. The United States Government has appropriated 25,000 dols. for this work, and a steam dredger, two scows, and nine men are engaged in scooping up the bed of the river at the rate of 30 cubic yards per day. The dredger is now cutting a channel through the lower falls 20 ft. wide and 4 deep for a distance of 400 ft.

American Steam Navigation.—Preliminary measures have been taken at New York for the establishment of an American line of steamers between New York and Antwerp. Antwerp, it is said, is determined to have a line of steamers to New York, and is willing to assist any good American line which may be started.

Rhone and Mont Cenis Railway.—In the course of last year, the Paris, Lyons, and Mediterranean Railway Company reconstructed and consolidated some works upon the completed portion of the Rhone and Mont Cenis Railway between the Rhone and St. Michel. Between St. Michel and the Mont Cenis tunnel, a distance of 19½ miles, the works commenced in 1869 were prosecuted with activity during the whole season of 1870. Notwithstanding difficulties occasioned by political events, and also by the rigours of an exceptionally severe winter, the St. Michel and Mont Cenis section will be completed by the end of this month (September, 1871), when traffic is expected to be commenced through the tunnel. The outlay of capital last year upon the St. Michel and Mont Cenis section amounted last year to 308,956*l.*

Gas for Paramatta.—Gas is about to be introduced at Paramatta, New South Wales. Each of the townships of Sydney is now getting a supply of gas.

Gold Mining in Victoria.—The number of alluvial gold miners in Victoria was computed last year at 43,879. The number of quartz miners was 16,486, making an aggregate of 60,365. In 1869 the number of alluvial miners was 51,024, and the number of quartz miners 16,564, making an aggregate of 67,588.

Telegraph Poles.—A new telegraph pole has been recently patented in the United States. The pole is made of galvanised iron tubes, which can be packed one within the other, like a telescope, and can, therefore, be transported to distant points with great ease, and at a moderate cost. For a pole standing 15 ft. out of the ground the first section is 3½ in. in diameter, the second section 2½ in., and the third section 1½ in.

Canadian Pacific Railway.—The arrival is noted at Vancouver's Island of nine surveyors of the Canadian Pacific Railway. These surveyors intended to start again as soon as possible to survey the country lying between Fort Ramloops and the hills on the east side of the Rocky Mountains. The survey of the coast will be delayed until a line through the Rocky Mountains has been selected. Two parties of engineers, one commanded by Mr. W. Moberly, and the other by Mr. M'Lellan, will probably winter in the mountains, while another party, under Mr. F. Moberly, will work west from Fort Garry to connect with the former. Several surveyors of British Columbia will be attached to the survey, and it is calculated that there will not be less than 100 men employed when the surveying parties are completed.

Canadian Salaries.—The salary of the secretary of the Intercolonial Railway has been increased from 2000 dollars to 2609 dollars per annum. Four district engineers of the line now receive 3000 dollars per annum each, with 600 dollars per annum each for horse hire and travelling expenses.

War Damages.—The Paris, Lyons, and Mediterranean Railway did not escape wholly the effects of the German invasion. The pecuniary injury inflicted upon works of art upon the system is estimated at 58,800*l.*

Florence Telegraphic Congress.—Colonel Robinson, R.E., has been ordered to proceed from India to Florence to attend a telegraphic congress about to be held in that city. Colonel Murray will officiate as director-general of telegraphs in India during Colonel Robinson's absence.

Intercolonial Railway.—The commissioners of the Intercolonial Railway have purchased from the contractors for the Eastern Extension Railroad, two locomotives for 17,000 dols., 25 platform cars for 10,000 dols., and 1 second-class car for 8158 dols. This rolling stock is to be used on that part of the Eastern Extension Railroad open between Painsec Junction and Amherst.

Steam Power in Victoria.—The number of steam engines employed in connexion with alluvial gold mining in Victoria, last year, was 403, of an aggregate force of 9915 horse power. In 1869, the corresponding number of engines was 408, of an aggregate force of 9650 horse power. The number of steam engines employed in connexion with the treatment of quartz in Victoria, last year, was 714, of an aggregate force of 13,573 horse power, as compared with 677, of an aggregate force of 12,796 horse power, in 1869.

Canadian Lighthouses.—A new light house at Cape Chatte will be ready for lighting next week. A new lighthouse at river Magdalene is also nearly fit for service.

French Mechanical Industry.—The mechanical establishments of France now display a considerable amount of activity. One firm has received an order for a bridge, which the Northern of France Railway Company is about to throw over the Oise.

Philadelphian Steam Shipbuilding.—The directors of the American Steamship Company of Philadelphia, have let a contract for four first-class iron steamers to Messrs. W. Cramp and Sons, of that city. Each steamer is to cost 520,000 dollars.

THE MONT CENIS TUNNEL.—The total expenses of the Mont Cenis Tunnel amount to 65,000,000 francs: of these 20,000,000 francs are to be contributed by the Victor Emmanuel Railway, or Railway of Northern Italy. This sum is to be paid on or before the opening of the tunnel. The French Government was to pay 12,000,000 francs if the work was accomplished within twenty years, reckoning from 1862. But if the work was accomplished at an earlier date France bound herself to pay 500,000 francs more for every year gained upon the stipulated time. As there have been eleven years thus gained, France will have to pay 5,500,000 francs besides the 20,000,000 francs of the original stipulation. She has, besides, to pay 5 per cent. interest on the money due for the work as it proceeded from year to year. Thus Italy will pay something less than 20,000,000 francs. Had the construction of the tunnel continued beyond the stipulated term of twenty years, Italy would have lost 500,000 francs for every year in excess of that period.

PRIZE ESSAY ON THE BALANCE SPRING.—We notice that the council of the British Horological Institute has announced to the members and horologists, that the Baroness Burdett Coutts has liberally offered a prize of 50*l.* for an essay on the balance spring, the conditions of competition for which, as approved by her ladyship, are as follows: The balance spring and its isochronal adjustments must be treated theoretically and practically. The judges in deciding the merits of the respective essays will be guided by the treatment of the following points, first, a description of the various springs applied to time-keepers and their results; second, the practical details for making the same with an account of the necessary tools; third, modes of obtaining the isochronism of the spring and its application to various escapements; fourth, the essay should further contain the method of adjustments for different temperatures and positions, and it is desirable that a short history of the spring should be appended. The text will be more easily understood if illustrated by drawings. The competing essays must be delivered in, on or before the 1st March, 1872, under cover to the secretary at the institute. Each treatise must be marked with some device or motto, and should be accompanied by an envelope similarly marked containing the name and address of the writer, only to be opened if the essay is successful. The judges will have the power of awarding a less amount should none of the essays be considered worthy of the prize offered. The judges will be requested to give their decision in not more than one month from the time of receiving the essays for award. The writer of the essay to whom the prize shall be awarded, shall be entitled to the copyright. The council reserving the right of publishing it in the journal in whole or part as they think fit, but not till six months have expired after the adjudication and payment of the award. By the special invitation of Baroness Burdett Coutts, the Astronomer-Royal, Sir Charles Wheatstone, and Mr. J. F. Cole, have consented to act as judges in the matter.

then led off to a chimney by a descending flue fitted with a sliding damper, as shown. The gases from the blast furnace are brought to the boilers by a flue beneath the ground level at the front end, as shown in the longitudinal section, gas mains, arranged as shown in the various views, conducting the gases from the flue to the combustion chambers. The longitudinal section and front elevation also show the construction of the nozzles at which the gases are burnt. The combustion chambers are all fitted with ordinary firegrates, for use if required, the mouths of the ashpits being, of course, however, under ordinary circumstances, closed airtight. Each boiler is provided with a steam dome, two safety valves, and all the necessary fittings, and the whole arrangement and details are very neatly worked out. In conclusion, we should state that the boilers have been made from the designs, and under the direction, of Mr. Charles Wood, the engineer to the Tees Iron Works.

DANKS'S PUDDLING FURNACE.

*A Description of Danks's Patent Revolving Puddling Furnace.**

By Mr. Samuel Danks, of Cincinnati, Ohio, U.S.A.

The author stated that experiments were commenced in the Cincinnati Railway Iron Works, in May, 1868, with a small revolving furnace to puddle from 250 to 300 lb. per heat. Successful results being obtained, two larger furnaces were built, and were got to work in April, 1869, since which period they have continued in regular operation, and are now at work. Several improvements have, however, from time to time, been made in them and adopted. In April, 1870, the above company, finding that the work and results obtained were so satisfactory, ordered the removal of all their old hand puddling furnaces as fast as the revolving ones could be erected. They are now puddling exclusively with the machine puddlers, and are making puddled balls 700 lb. in weight. In February, 1871, the Rome Iron Company, at Chattanooga, Tennessee, commenced working a 700 lb. furnace, and contracted for ten more. Particulars were given by the author of the various works in the United States, where the revolving puddling furnace has been adopted, among which are the Ohio Falls Co., New Albany, Indiana, the Jones and Langlin Works, Pittsburgh, Pa., Akins Brothers' Works, Pottsville, Pa., the Indianapolis Rail Mill Co., and the Atalanta Rolling Mill Co., Georgia; and at all these establishments it is asserted that the machine has worked very satisfactorily.

The furnace has a firegrate in outward appearance like the ordinary puddling furnace, but it differs from this considerably in several particulars. It is supplied with a fan blast under the grate to urge the fire and produce gas. It has also jets of fan blast over the fire injected for the purpose of insuring the more perfect combustion of the fuel. This blast is regulated by a valve, by which the workman has a perfect control of the quantity of gas generated and consumed, and is thus enabled to make the temperature suit the requirements of the charge in the different stages of the puddling process. The ashpit and firehole are closed by doors to prevent the escape of the blast except through the fire, and the firehole has a coil of wrought-iron water-pipe cast into it for the purpose of allowing a stream of water to circulate around it to keep it cool. A similar coil is inserted in the bridge plate between the fire and a charge of metal. Fastened on to the bridge-plate is a ring with a flat surface on one side, which ring has a pipe or pipes cast into it, and is made in one piece, or in sections. This forms a butt joint with the revolving part of the furnace. The face is cast on a metal chill to harden the part exposed to abrasion from the end of the revolving chamber rubbing against it.

The revolving chamber is made of two end pieces, so formed as to be banded together with wrought-iron bands, and to have detachable rings on the part most exposed to the fire. It rests on carrying rollers to allow its free rotation, and has also suitable ribs for strengthening it, with holes for rivetting the rings and stave plates upon it. The two ends are connected together by a series of stave plates to form a cylinder, and are of suitable length, according to the desired size of the chamber. They have hollow ribs running longitudinally, which serve the double purpose of holding the fettling, and keeping it cool, and, when rivetted together, form an open-ended cylinder, one end of which butts against the ring that is fastened to the bridge plate, where the gases are admitted over the bridge from the grate, and the other open end serves the purpose of a doorway for the reception of the charges of iron, and also for their removal, as well as for the escape of the products of combustion through a movable headpiece, which connects the revolving chamber and the chimney. This piece can be moved at pleasure by means of a suitable apparatus overhead, and, when in its place for puddling, the escaping gases pass through it into the stationary flue, and thence to the chimney or boiler. When adjusted for puddling, the piece is held in position by suitable props, and balls of great weight can be removed from the furnace very readily, the end being open. It has also an arrangement of water pipes for keeping it cool, and a stopper hole in front, so that the operations going on inside can be seen at all times.

The vessel is made to revolve by means of a toothed wheel fixed longitudinally upon it. A suitable engine is attached to each machine so that the chamber can be made to revolve at any speed that may be required according to the different stages of the operation. The most important feature in connexion with the invention is the lining of the vessel. The foundation consists of what is termed the "initial" lining, which is composed of a mixture of pulverised iron ore and pure lime, worked with water into the consistency of a thick paste. The method of putting on this "initial" lining is fully described, and when completed the author says that upon it is placed the fettling proper. A quantity of pulverised iron ore about one-fifth of the total amount required to fettle the apparatus is thrown in, the furnace is heated and made to revolve slowly until the iron is found to be completely melted, and the apparatus is then stopped. That part of the molten iron which has not been consumed by glazing the "initial" lining surface runs to the lowest level of the furnace, and there forms a pool, into which there are put a number of small and large lumps of iron ore of such dimensions as will be required to allow the said lumps to project over the surface of the liquid ore by from two to six inches. This part of the fettling is allowed to set when a fresh quantity of pulverised ore is thrown in. The furnace is again made to rotate slightly until the newly added ore is liquefied, when the apparatus is again stopped, and the pool is filled with lumps as before. The operation is continued in this way until the whole of the vessel is properly fettled. From 2 to 2½ tons of iron ore are required to fettle a 700 lb. furnace. The iron is charged into the furnace either in a solid or molten condition. When charged in the shape of pig iron, the melting down occupies from 30 to 35 minutes, during which a partial rotation is given to the furnace from time to time, in order to expose equally all sides of the charge to the flame. When the whole of this is thoroughly melted, the furnace is made to rotate once or twice per minute only during the first five or ten minutes, in order to obtain the most perfect action of the cinder upon the molten iron. A stream of water is injected through the stopper hole along and just above the line of contact between the floating cinder and the inner surface of the vessel on the descending side. A certain portion of uncontaminated cinder is thereby solidified on the metal surface, and is carried down into or below the bath of molten iron in a continuous stream, which, in rising up through the iron, combines with the impurities of the latter in a far more effectual and complete manner than any mode of puddling hitherto known can effect. On the expiration of the said five or ten minutes, the iron begins to thicken, and the motion is stopped. The heat is then raised so that the cinder shall be perfectly liquefied, and the vessel is brought into such a position that the tap hole shall be just over the level of the iron, which by this time has become partly pasty. The puddler gently pushes back the iron and the cinder is made to run off. The heat is again raised, and the furnace is put in motion at a velocity of from six to eight revolutions per minute, by which means the charge is dashed about violently in the furnace. A high temperature being kept up, and the charge being continually turned over, the particles begin to adhere, when the velocity of the apparatus is lowered to from two to three revolutions per minute, upon which the ball then very speedily forms. The puddler then solidifies the front end of the ball by a few blows from a tool applied through the stopper hole. The props of the movable piece are then removed, and the flue hanging from the overhead rail is moved away. A large fork suspended from a crane is put into the vessel along one side, and the ball, which by a turn of the vessel is rolled on to the fork, is then taken out by means of a crane. The ball is then worked in a squeezer. The flue is replaced after the requisite quantity of cinder and metal have been again charged, and the process is continued. From eight to ten charges are made before any refettling is required, and these heats are worked in a day of 10 hours. The writer gave results that have been furnished to him, as obtained at different works, by the use of revolving puddling furnaces. The following may be taken as a sample of these: Puddling cold pigs charged at the Cincinnati Railway Works for week ending July 8th, 1871:

	lb.
184 heats, 600 lb. each	110,400
Product of rail tops	110,811
Gain	411 lb. or 0.6 per cent.

Time, 5 furnaces 4 days, and 4 furnaces 1 day. A day lost, in consequence of the national holiday, on July 4th. Week ending July 15, 1871:

	lb.
218 heats of cold pig, charged 600 lb. each	130,800
Product (tops)	136,934
	6,134 lb. or 4.69 per cent.

Furnaces at work, 4 for 2 days, 5 for 5, 6 for 1 day. Quality of pig used, half inferior, weak, cheap, and half fair charcoal. Thermometer ranged above 90° during the above period, and most of the ordinary iron working had to be stopped a part of the time. The excess of product over the weight charged is caused by the richness of the fettling used. Mr. Danks claimed for the revolving furnace the following advantages: A great saving in the cost of labour and also in the consumption of coal, varying according to the size of the furnace; a superior and more regular quality of puddled iron from a given quality of pig; a yield of puddled iron much in excess of the charge of pig metal, instead of the usual loss, the extra yield being obtained by the reduction of the rich fettling used in the machine; eight to ten heats, whether of from 3 to 10 cwts. are made in a day of ten hours, when suitable metal is used; the refining process is very complete, the whole of the phosphorus, and silica, and the sulphur, to a large extent, being removed by the chemical action of the lining mixture; the very heavy and exhaustive labour of puddling is performed by steam power, thereby enabling one skilled man to attend to the working of a large quantity of iron; the bringing to nature and balling of the iron is completed by the rotary action, without the use of rabbling, except when the heat has to be divided into smaller balls, and the capacity may be suited for heats of any weight from 5 cwt. upwards. The cost of the furnace, weight of product considered, is about the same as that of the usual hand puddling furnaces.

In order, however, that these advantages may be obtained to their full extent, by the use of this new form of puddling furnace, it is essential that the whole of the arrangements connected with the manipulation of the iron may be upon a suitable scale.

It is almost needless to say that the existing arrangements for hammering and rolling puddled iron would not be suitable, where such large masses of puddled iron have to be dealt with. In proportion as the subsidiary appliances are carried out upon a proper scale, so will be the advantageous results obtained from the puddling apparatus.

As a further evidence of its undisputed success in America, the Great Industrial Exposition, held in Cincinnati, in 1870, awarded a special gold medal to the writer "for his valuable invention," and this award was made after the judges on that class of machines had personally witnessed its great success in doing all that he claims for it, and who were previously sceptical of the possibility of such yield and quality of product, and also of such a saving of material as they saw effected in the furnaces.

In the course of the discussion Mr. Fothergill, M.P., stated that he had seen Mr. Menelaus's puddling machine at Dowlais at work, but he found there were two great practical difficulties in connexion with it. The first was that the fettling was destroyed by the breaking down of the iron, and, secondly, the fettling was so highly silicious that the quality of the iron was completely destroyed. It appeared from what was stated in the paper that Mr. Danks had overcome these difficulties.

Mr. E. Williams (Middlesbrough) did not see any material difference between the machine of Mr. Danks and that of Mr. Menelaus; and it appeared to him that what could be done with the one machine could be done with the other. The lining in both furnaces was thick, and it seemed to him that the point to be aimed at was to get a furnace with a thin lining cooled by water from the outside.

Mr. Kitson urged that the council of the institute should go to the expense of erecting one of Mr. Danks's furnaces, and practically test the benefit claimed for it.

Mr. Menelaus said no one would have rejoiced more than he should if Mr. Danks had really succeeded in overcoming the difficulties which met him in his endeavours to produce puddling by means of machinery. He had been in treaty with Mr. Danks for the erection of one of his machines; but as this involved great expense, they had not yet come to terms, as he (Mr. Menelaus) was anxious the matter should be commercially satisfactory. In order to test the truth of the statements made in the paper, he would suggest that the funds at the disposal of the puddling committee should be expended in sending a commission to America to investigate the subject. If, however, this was not done he and some others were determined to go to the expense of sending such a commission on their own account; but, however the thing was done, the information gained would be equally at the service of the members of the institute.

After some remarks from Mr. Walter Williams, of West Bromwich,

Mr. Danks said that he would give every facility to any commission that might be sent to America to investigate his invention. He then proceeded to give some further details respecting the working of his machine, and to reply to points which had been raised in the course of the discussion.

The Hague and Rotterdam Steam Fire Engines.—Very satisfactory results have been obtained from these engines built by Messrs. Merryweather and Sons. The engine for the Hague delivered 5 per cent. more water than the quantity stipulated, whilst the performance of the Rotterdam engine exceeded the promised quantity by 50 gallons per minute. It is satisfactory to the English engineering trade in general to give proof that their productions, as in this instance, are rather under-rated in their powers, than in giving out results which they cannot maintain.

The New Metropolis Water Act.—On Saturday was issued the Act to amend the Metropolis Water Act, 1852, and to make further provision for the due supply of water to the metropolis and certain places in the neighbourhood thereof. There are 51 sections in the Act and three schedules. The object of the statute, as expressed in the preamble, is to make further provision for securing to the metropolis a constant supply of pure and wholesome water. It is with the recited Act (15 and 16 Vic., c. 84) to be construed as one Act. "From and after the passing of this Act (August 21), every company shall on Sundays, as on other days, supply sufficient pure and wholesome water for the domestic use of the inhabitants within their water limits." After eight months from the passing of the Act, every company, when required so to do in the manner directed, is to provide and keep throughout its water limits a constant supply of water for domestic purposes, and make such water reach the top story. After six months from the passing the metropolitan authority may make application for a constant supply within such district; and when not provided an appeal is given to the Board of Trade. There are various regulations set forth in the statute, which are to be published, and penalties to be recovered for non-compliance. The companies may require owners and occupiers to provide proper "fittings," which term includes communication pipes, and also all pipes, cocks, cisterns, &c., used or intended for supply of water by a company to a consumer, and for that purpose placed in or about the premises of the consumer. Power is given to enter premises for the inspection and repair of the fittings. There are provisions as to fire-plugs. The Board of Trade may appoint persons to inquire and report upon the quality of the water. There are various other provisions to carry out the preamble, and there is a section that an incoming tenant is not to pay the arrears of the outgoing tenant unless by express agreement. The schedules annexed to the statute explain the metropolitan authority, the districts, and the companies mentioned in the Act.

* Abstract of paper read before the Iron and Steel Institute. One form of Mr. Danks's furnace was illustrated by us in our last number.

THE NEW YORK CANAL COMMISSION.

THE Commission appointed by law to examine inventions, and apportion the reward of one hundred thousand dollars for improved canal boat propulsion, lately held their first meeting at Albany, N.Y. The Commission consists of Gen. B. MacClellan, Horatio Seymour, Erastus S. Prosser, David Dows, George Geddes, Van R. Richmond, Willis S. Nelson, George W. Chapman, William W. Wright, and John D. Fay. Van R. Richmond was elected chairman, H. A. Petrie, secretary, David M. Greene, engineer. The following resolutions were adopted:

Resolved, That for the purpose of carrying out the intent of the law, this Commission will require, among the tests to be made, that the several competitors shall make not less than three round trips from New York and Buffalo or Oswego, each boat to be loaded with not less than two hundred tons of cargo each way, the trips to be commenced as soon as any party is ready and all completed in the least practicable time. For the purpose of determining the time consumed by each and all the trips, the clearance must show the day of the month and time of day that the boat passes each collector's office; certified copies thereof to be furnished to the Commission. In order to obtain information in regard to the practical working of the several devices in competition, as soon as practicable, the engineer of the Commission, David M. Greene, of Troy, will inspect the same from time to time, as in his judgment may be necessary, and report the facts obtained to this Commission.

Resolved, That competitors are hereby notified that, for the purpose of carrying out the intent of the law, though it is desirable that the three consecutive round trips from Buffalo or Oswego to New York be made at the earliest time practicable, that the whole of the year 1872 will be allowed to such persons as may desire so much time, and that the awards will not be made until the close of navigation in that year.

The next meeting of the Commission was fixed for August 14th, at the office of the Canal Commissioner, Syracuse, N.Y. Persons who desire to communicate with the Commission should address Henry A. Petrie, secretary, office of the State Engineer, Albany, N. Y.

INDIAN ENGINEERING EXAMINATION.

TO THE EDITOR OF ENGINEERING.

SIR,—Having allowed us through your paper to state briefly our grievances in reference to the Indian P. W. D. examination, would it be trespassing too much upon your goodness to ask you to give a short article in your next issue, as there can be no doubt but that we were shamefully treated; many of us poor men were brought up to London when the college authorities well knew that they had not the slightest intention of nominating us; the four passed can only have been appointed as "a blind." Could it have been otherwise? Had twelve or eighteen men passed, the public would immediately inquire for what reason had 120,000*l.* to 160,000*l.* of public money been expended; as it must be remembered that when the idea of a college was mooted in 1870 it was put down by public opinion, in which year, in order to better substantiate the claim for a college only eleven men were allowed to pass; this year the college is established, it is then given out that there will not be another competitive examination, they are again forced to give in, and the late examination was held, at which two out of the three examiners were college professors. Should you not deem it expedient to accede to my wishes, will you kindly insert the following letter, which, considering the number of points, has been made as brief as possible.

Faithfully yours,

GRAHAM SMITH (No. 7), Stud. Inst. C.E.

39, Warwick Gardens, Kensington, August 26, 1871.

TO THE EDITOR OF ENGINEERING.

SIR,—I do not wish to trouble you with a repetition of the letters which have already appeared in your columns under this head, I would only say that all facts stated in them are as true as it is extraordinary that such a mode of conducting an examination should be allowed.

The complaints which I would beg you to give me space for, are:

1st. The way in which the unsuccessful candidates have been treated as to the results of their labours. I am myself one of these. The only communication I received after the examination was to the effect that I was not through.

Now, Sir, the object of an examination, to my mind, is to ascertain the proficiency, in order, of the candidates in the subjects they are examined in, and if it so turns out that but few of them come up to the required standard for the appointments they are competing for, it is to be hoped that the rest may still be fit for something, and therefore their positions in the list ought to be made known to them, so that those who held good ones may be able to mention the fact in applying for other appointments. This is always done in the Indian Civil Service Examination, and was done in the late Engineering College Examination. It was not done in the late Direct Appointments Examination.

This being the case, I applied to the India Office to know my position. In return, I could only get a copy of my marks, which left me as ignorant as before as to my place; on my writing again for the required information my letter was simply ignored.

This treatment, after I have spent more than three years in preparing for the examination, seems somewhat hard, as one has apparently nothing to show for real hard work, and all engineers of the present day know how difficult it is to obtain employment, and how valuable a good recommendation may prove to a young man in starting in the profession. I do hope this matter will be reconsidered, and each candidate furnished with a list.

2nd. The intention of the Government to give no more chances of appointments in India to the men who have been preparing for these examinations. It should be remembered that our course extends over at least three years, and it is now only one since the college was first talked of.

Surely those who have lately failed, and can prove that they have been looking forward to these examinations, should be allowed to compete with the members of the college without passing the preliminary examination which their age puts out of their power.

"Fair Play is a Jewel," and unless some such arrangement is made, I, for one, shall gather that such is not the motto of the authorities of the India Office.

I am, Sir, your obedient Servant,

J. H.

IRON RAILWAY SLEEPERS.

TO THE EDITOR OF ENGINEERING.

SIR,—In your edition of the 25th of August I notice a characteristic letter from the pen of Mr. Greaves, who, I think, might have contented himself with simply correcting the error you made in crediting my sleepers with a test made upon one of his, and which error might possibly arise from the fact that Messrs. Richardson and Sons are engaged upon a contract for 6000 tons of my sleepers.

With regard to the test by falling weight, I have inspectors' reports, showing tests quite equal to that of Mr. Greaves's sleeper, but consider such results quite exceptional.

I have also noticed that sleepers of small area and light weight give higher results than larger and heavier sleepers.

Mr. Greaves says: "The result was equally unsatisfactory when the engineers for whom they were made had some of them sent up to the testing machine at Lambeth."

Such, however, is not the case. Mr. Edward Woods, C.E., who ordered the testing of these sleepers, desires me to say that he was perfectly satisfied with the result of the testing he witnessed. The first sleeper tested broke at 9 ft., the tup, weighing 3¼ cwt., having fallen upon the sleeper seventeen times, commencing at 1 ft., and rising 6 in. after each blow.

But perhaps the best refutation to the uncalled-for statements made Mr. Greaves in your journal and elsewhere, is the fact of the large and increasing adoption of my various systems of permanent way.

During the last few years more than 150,000 tons have been cast for various railways abroad, and at the present moment a number of contracts are in hand, five of which are for extensions of railways already laid with my sleepers.

I am, Sir, yours &c.,

JAMES LIVESEY.

9, Victoria Chambers, Westminster, London, S.W.,
August 31, 1871.

FOREIGN AND COLONIAL NOTES.

Iron in Guayaquil.—Advices from Guayaquil report the discovery of iron in great abundance on the banks of the river Daoli. Surrounding forests produce plenty of wood which can be converted into charcoal, and used in working the iron ore.

Surveys in Manitoba.—Mr. Lindsay Russell, C.E., has been appointed inspector of surveys in Manitoba. Mr. Russell has left for the scene of his future duties.

The Merrimac.—The Merrimac river is now in course of improvement at Mitchell's lower falls, about three miles above Haverhill, Massachusetts. The United States Government has appropriated 25,000 dols. for this work, and a steam dredger, two scows, and nine men are engaged in scooping up the bed of the river at the rate of 30 cubic yards per day. The dredger is now cutting a channel through the lower falls 20 ft. wide and 4 deep for a distance of 400 ft.

American Steam Navigation.—Preliminary measures have been taken at New York for the establishment of an American line of steamers between New York and Antwerp. Antwerp, it is said, is determined to have a line of steamers to New York, and is willing to assist any good American line which may be started.

Rhone and Mont Cenis Railway.—In the course of last year, the Paris, Lyons, and Mediterranean Railway Company reconstructed and consolidated some works upon the completed portion of the Rhone and Mont Cenis Railway between the Rhone and St. Michel. Between St. Michel and the Mont Cenis tunnel, a distance of 19½ miles, the works commenced in 1869 were prosecuted with activity during the whole season of 1870. Notwithstanding difficulties occasioned by political events, and also by the rigours of an exceptionally severe winter, the St. Michel and Mont Cenis section will be completed by the end of this month (September, 1871), when traffic is expected to be commenced through the tunnel. The outlay of capital last year upon the St. Michel and Mont Cenis section amounted last year to 308,956*l.*

Gas for Paramatta.—Gas is about to be introduced at Paramatta, New South Wales. Each of the townships of Sydney is now getting a supply of gas.

Gold Mining in Victoria.—The number of alluvial gold miners in Victoria was computed last year at 43,879. The number of quartz miners was 16,486, making an aggregate of 60,365. In 1869 the number of alluvial miners was 51,024, and the number of quartz miners 16,564, making an aggregate of 67,588.

Telegraph Poles.—A new telegraph pole has been recently patented in the United States. The pole is made of galvanised iron tubes, which can be packed one within the other, like a telescope, and can, therefore, be transported to distant points with great ease, and at a moderate cost. For a pole standing 15 ft. out of the ground the first section is 3 in. in diameter, the second section 2½ in., and the third section 1½ in.

Canadian Pacific Railway.—The arrival is noted at Vancouver's Island of nine surveyors of the Canadian Pacific Railway. These surveyors intended to start again as soon as possible to survey the country lying between Fort Kamloops and the hills on the east side of the Rocky Mountains. The survey of the coast will be delayed until a line through the Rocky Mountains has been selected. Two parties of engineers, one commanded by Mr. W. Moberly, and the other by Mr. M'Lellan, will probably winter in the mountains, while another party, under Mr. F. Moberly, will work west from Fort Garry to connect with the former. Several surveyors of British Columbia will be attached to the survey, and it is calculated that there will not be less than 100 men employed when the surveying parties are completed.

Canadian Salaries.—The salary of the secretary of the Intercolonial Railway has been increased from 2000 dollars to 2600 dollars per annum. Four district engineers of the line now receive 3000 dollars per annum each, with 600 dollars per annum each for horse hire and travelling expenses.

War Damage.—The Paris, Lyons, and Mediterranean Railway did not escape wholly the effects of the German invasion. The pecuniary injury inflicted upon works of art upon the system is estimated at 58,800*l.*

Florence Telegraphic Congress.—Colonel Robinson, R.E., has been ordered to proceed from India to Florence to attend a telegraphic congress about to be held in that city. Colonel Murray will officiate as director-general of telegraphs in India during Colonel Robinson's absence.

Intercolonial Railway.—The commissioners of the Intercolonial Railway have purchased from the contractors for the Eastern Extension Railroad, two locomotives for 17,000 dols., 25 platform cars for 10,000 dols., and 1 second-class car for 3153 dols. This rolling stock is to be used on that part of the Eastern Extension Railroad open between Painsec Junction and Amherst.

Steam Power in Victoria.—The number of steam engines employed in connexion with alluvial gold mining in Victoria, last year, was 403, of an aggregate force of 9916 horse power. In 1869, the corresponding number of engines was 408, of an aggregate force of 9650 horse power. The number of steam engines employed in connexion with the treatment of quartz in Victoria, last year, was 744, of an aggregate force of 18,572 horse power, as compared with 677, of an aggregate force of 12,706 horse power, in 1869.

Canadian Lighthouses.—A new light house at Cape Chatte will be ready for lighting next week. A new lighthouse at river Magdalene is also nearly fit for service.

French Mechanical Industry.—The mechanical establishments of France now display a considerable amount of activity. One firm has received an order for a bridge, which the Northern of France Railway Company is about to throw over the Oise.

Philadelphian Steam Shipbuilding.—The directors of the American Steamship Company of Philadelphia, have let a contract for four first-class iron steamers to Messrs. W. Cramp and Sons, of that city. Each steamer is to cost 520,000 dollars.

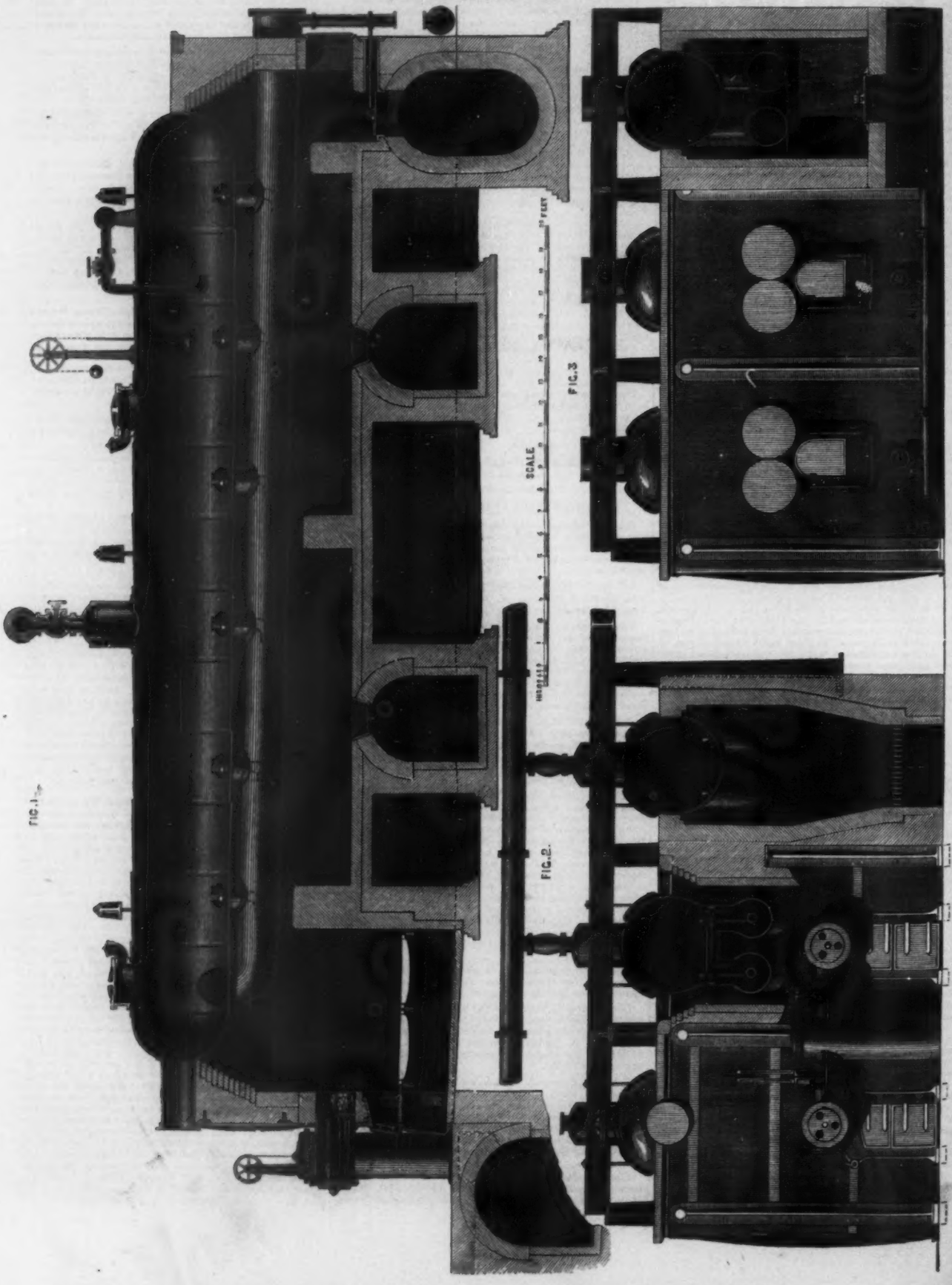
THE MONT CENIS TUNNEL.—The total expenses of the Mont Cenis Tunnel amount to 65,000,000 francs: of these 20,000,000 francs are to be contributed by the Victor Emmanuel Railway, or Railway of Northern Italy. This sum is to be paid on or before the opening of the tunnel. The French Government was to pay 12,000,000 francs if the work was accomplished within twenty years, reckoning from 1853. But if the work was accomplished at an earlier date France bound herself to pay 500,000 francs more for every year gained upon the stipulated time. As there have been eleven years thus gained, France will have to pay 5,500,000 francs besides the 20,000,000 francs of the original stipulation. She has, besides, to pay 5 per cent. interest on the money due for the work as it proceeded from year to year. Thus Italy will pay something less than 20,000,000 francs. Had the construction of the tunnel continued beyond the stipulated term of twenty years, Italy would have lost 500,000 francs for every year in excess of that period.

PRIZE ESSAY ON THE BALANCE SPRING.—We notice that the council of the British Horological Institute has announced to the members and horologists, that the Baroness Burdett Coutts has liberally offered a prize of 50*l.* for an essay on the balance spring, the conditions of competition for which, as approved by her ladyship, are as follows: The balance spring and its isochronal adjustments must be treated theoretically and practically. The judges in deciding the merits of the respective essays will be guided by the treatment of the following points, first, a description of the various springs applied to time-keepers and their results; second, the practical details for making the same with an account of the necessary tools; third, modes of obtaining the isochronism of the spring and its application to various escapements; fourth, the essay should further contain the method of adjustments for different temperatures and positions, and it is desirable that a short history of the spring should be appended. The text will be more easily understood if illustrated by drawings. The competing essays must be delivered in, on or before the 1st March, 1872, under cover to the secretary at the institute. Each treatise must be marked with some device or motto, and should be accompanied by an envelope similarly marked containing the name and address of the writer, only to be opened if the essay is successful. The judges will have the power of awarding a less amount should none of the essays be considered worthy of the prize offered. The judges will be requested to give their decision in not more than one month from the time of receiving the essays for award. The writer of the essay to whom the prize shall be awarded, shall be entitled to the copyright. The council reserving the right of publishing it in the journal in whole or part as they think fit, but not till six months have expired after the adjudication and payment of the award. By the special invitation of Baroness Burdett Coutts, the Astronomer-Royal, Sir Charles Wheatstone, and Mr. J. F. Cole, have consented to act as judges in the matter.

GAS-HEATED BOILERS AT THE TEES IRON WORKS, MIDDLESBROUGH.

CONSTRUCTED FROM THE DESIGNS OF MR. CHARLES WOOD, ENGINEER.

(*For Description, see Page* 139.)



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ENGINEERING is registered for transmission abroad.

PUMPING ENGINES AT THE BRUNSWICK WATER WORKS: ERRATUM.—In our account of these engines last week, the diameter of the pump cylinder was erroneously given in one place as 16½ in. The correct diameter is 17½ in., as stated in that part of the description relating to the details of the pumps.

THE "ENGINEERING" DIRECTORY is published this week on the thirteenth page of our advertisement sheet.

NOTICE TO AMERICAN SUBSCRIBERS.

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of* 1*l.* 14*s.* 8*d.* ($8.32, *gold*) *per annum, payable in advance.*

CONTENTS.

	PAGE
The "Watertaxi" of Holland	133
Burt's Dredging Machine	133
Locomotive Fitments used on the Kaiserin Elizabeth Railway	135
Cleveland Blast Furnaces	136
Hot Blast Stoves	136
Perrie's Blast Furnace	137
Height of Blast Furnaces	137
Gases from the Bessemer Converter	137
Bennett's System of Steam Cultivation	138
The Royal Agricultural Society's Show at Cardiff	138
Boilers at the Tees Iron Works Middlesbrough	139
Danks's Puddling Furnace	140
Iron Railway Sleepers	141
Foreign and Colonial Notes	141
Indian Engineering Examination	141
The New York Canal Commission	141
Portable Engine Trials	143
Railway Servants	143
The Sewage Question in Paris	144
Literature	145
The Iron and Steel Institute	145
Notes from Paris	146
Recent Patents	147
Testing Submarine Telegraph Cables	147
The Stowmarket Explosion	148
Notes from the South-West	148
Notes from the North	149
Notes from Cleveland and the Northern Counties	149
Overworked Railway Employés	150
Mackie's Perforator	150

ENGINEERING.

FRIDAY, SEPTEMBER 1, 1871.

PORTABLE ENGINE TRIALS.

WE publish on another page of the present number the regulations just issued by the Royal Agricultural Society, respecting the trials of portable engines and thrashing machines which are to take place during the next year's meeting at Cardiff. Of the thrashing machine trials we have no desire to speak here, but the regulations for the trials of the engines possess great interest for a large body of our readers and, from the important position which these tests have of late years assumed, it is desirable that we should consider in detail the conditions under which they will be carried on at Cardiff. And here we may remark, in the first place, that the Royal Agricultural Society and its officers have acted most wisely in issuing their regulations for the Cardiff show at the present early date instead of in the spring of the year in which the show is held, as has hitherto usually been the case. Ample time is thus afforded for intending competitors to make all their experiments and preliminary "runs," and this is the more especially important in the present instance, as the Society's programme for next year differs in some very important particulars from those adopted on former occasions. It is of these differences and the effect that they may be expected to produce, that we intend now to speak.

On the occasion of the last trials of portable engines carried out by the Royal Agricultural Society —namely, those held at Bury St. Edmund's in 1867 —the maximum pressure of steam allowed for the single-cylinder engines was 60 lb. per square inch, and each engine was tested with a load on the brake equal to its nominal horse power as calculated by the rule at that time adopted by the Society. This rule allowed ten circular inches of piston area per horse power, and the load was thus so light that a low piston speed was a necessity, unless recourse was had to objectionable throttling of the steam. The speeds at which the engines were run were left for the competitors to decide for themselves—and, indeed, this was almost the only detail of the trial they were allowed to determine—but a considerable amount of "overrunning" was permitted, and several of the exhibitors took advantage of this, and ran their engines at rates far above their nominal speeds, thus gaining the advantages of a higher piston speed, and reducing the losses by radiation, &c., during the run. We have on many occasions directed attention to the objectionable features of the system of testing engines formerly adopted by the Society, and four weeks ago (*vide* page 75), we suggested a method of conducting the Cardiff trials, which we believed, and still believe, would, if adopted, save the judges much trouble in making their awards, and at the same time leave to the competitors all that freedom of action which is so essential to progress. We are glad to find from the programme which has just been issued that the Council of the Society have regarded the matter in much the same light as ourselves, and have raised the steam pressure allowed to 80 lb., while they have also given the competitors all the desired freedom as to the speeds and loads at and against which their engines are to be run; but they have done this in a manner which we believe will be found to throw more work upon the judges than that which we suggested. It was proposed by us that the competing engines should be divided into classes, there being selected for each class a brake load, against which all the engines of that class were to be run, this load representing, as closely as possible, the average work an engine of that class would have to do in regular practice. The dimensions of the engines, we suggested, should, as well as the speeds at which they were worked, be left entirely in the hands of the competitors, thus giving ample scope for the introduction of engines with small cylinders and high piston speeds, by those who advocate them. Any engine, we suggested, should be eligible for trial in any of the classes, the sole condition being that it did fairly the amount of work corresponding to that class. From the programme before us, however, we find that the Royal Agricultural Society, instead of fixing upon certain loads against which the engines should be tested, have left the loads, as well as the running speeds, at the discretion of the competitors. This will increase the trouble of the judges, as they may have to decide between the merits of engines doing widely different amounts of work, while it will also cause the comparative results obtained to be of a kind which will be less generally appreciated by the users of portable engines than would be the case if a uniform system of loads had been adopted. At the same time, no greater liberty will really be afforded to the competitors, as the fact of being able to run an engine of any size against a certain brake load, is fully equivalent to that of being allowed to place any desired load on a given engine; but we are at the same time perfectly ready to admit that the latter plan affords certain facilities for the carrying out of preliminary experiments by the competitors, which are not possessed by the former.

We are glad to find from the programme that account will be taken, not merely of the coal, but also of the water and lubricating materials used, while only one man will be allowed to attend each engine, and no over-running will be permitted. Indicator diagrams will also be taken, and experiments will be made to test the promptness of action and efficiency of the governors with which the engines are fitted. These are all good points worthy of commendation, and if the programme be faithfully carried out, some very interesting data will be forthcoming. There is, however, one portion in programme to which, we regret to say, we must make a most earnest objection, this portion being that relating to the rule for calculating the "nominal" horse power of the engines. This rule is even more objectionable than such rules generally are. The term "nominal" horse power is, and has long been, an absurdity. In the earlier days of steam engine construction, the "nominal" power of an engine, as calculated by Watt's rule, represented, with a tolerable degree of accuracy, the actual power of the engine to which it referred, and the term thus possessed a certain commercial value. This state of affairs, however, has long ceased to exist, and this being the case, the term itself should cease to exist also. Above all, we must condemn an attempt to give to the terms "nominal" horse power a definite value dependent upon, but greatly below, the indicated power of an engine. The only excuse for employing the term "nominal" power at all is that the prefix "nominal" serves to distinguish the power of an engine deduced by calculations from the dimensions, &c., from that obtained by actual experiments, and used in this way the term would be justifiable in a number of instances, if care was taken to carry out the calculations in such a manner that the results obtained from them would actually represent closely the real power developed by the engine to which they referred. When once the actual indicated power of an engine is known, however, the rating of that engine, at any other than the actual indicated power, is manifestly a thing to be condemned, while especially must we condemn an attempt to rate an engine at a certain fixed fractional value of its indicated power. If the Royal Agricultural Society persist in adhering to the rule for nominal power given in their present programme, the effect will be to give to the term "nominal" horse power, as applied to portable engines, an appearance of scientific accuracy to which it has no claim whatever.

But the Society's new rule has another objectionable feature. Referring to the programme, it will be seen that it states that the nominal power of an engine will be taken as one-third of the indicated power developed by that engine when worked with steam of 60 lb. pressure, cut off at three-fourths of the stroke, and with the periphery of the fly-wheel running at a speed of 1884 ft. per minute. This speed corresponds with 100 revolutions per minute for a 6 ft. wheel, or 300 revolutions for a 2 ft. wheel, and it follows, from the nature of the rule, that, so long as the boiler has power to supply steam, a manufacturer may give his engine any "nominal" power he likes, simply by reducing the size of the fly-wheel. For instance, we may suppose the case of two engines, identical in every respect, except that one may have a fly-wheel 3 ft., and the other one 6 ft. in diameter; one of these engines would be rated by the Society's rule at twice the "nominal" power of the other, simply because its smaller diameter of fly-wheel would enable it to be run at a higher piston speed without transgressing the terms of the rule, it being supposed, of course, that the boiler is large enough to supply steam for the higher speed. The only good word we have to say for the new rule is that it is harmless as far as next year's trials at Cardiff are concerned—indeed, we do not see that the conditions of those trials require the employment of the term "nominal" horse power at all—and this is certainly a great point.

Taken altogether, the programme issued by the Royal Agricultural Society for the Cardiff trials bears strong evidence of a desire on the part of the engineering advisers of the society to treat the whole subject in a most liberal spirit, and to trammel in no way whatever the progress of portable engine construction. That the results will be most satisfactory we cannot but anticipate. The increase of pressure to 80 lb. per square inch will enable an effective expansion of quite fivefold to be resorted to, and the removal of the restrictions as to the proportions between the piston area and load on the brake will afford every inducement for the adoption of higher piston speeds and the production of a class of very light portable engines which would be of much service in many districts. Portable engine builders have every chance of distinguishing themselves at Cardiff next year, and it will be their own faults if they neglect the opportunity afforded them.

RAILWAY SERVANTS.

THE letter addressed by Mr. M. T. Bass to the chairman of the Midland Railway Company upon the existing conditions of service of some of the employés on that line, demands earnest attention. Mr. Bass has already made this subject his own, and we feel sure he will continue to labour at it until he has effected a reform no less needed on behalf of the servants themselves than by the public, for the latter are even more interested in the matter than the former. The examples of hours of service and of rates of wages selected by Mr. Bass are no exceptional ones; they illustrate a genera practice in railway management in this country, and they are justly calculated to arouse the greatest alarm and indignation on the part of the travelling community. Commencing with the engine drivers

on the Midland Railway, we find that 22 hours of continuous labour are not unknown; that for more than a day and night at a stretch the men are sometimes compelled to be upon their engines without rest, save such hasty moments as are surreptitiously obtained upon the foot plate. We find that the railway guards are more worked even than the drivers; that continuous duty of from 18 to 40 hours is not uncommon; whilst sometimes extended service for a week, during which time the unfortunate servant is unable to take his clothes off, is exacted.

With respect to signalmen this state of things, however, is far worse. Twelve hours of duty appears an ordinary period, during which time, at busy stations, they have no leisure for meals, and have to attend to all the duties connected with the goods trains, engines, shunting, and so forth. For example, at one of the boxes near Leeds about 220 trains pass each 24 hours, and each train has to be recorded in a book nine times. In this period "the beats on the bells give and take 6038 times; beats on the needles give and take 6150; levers to pull over 454. This is exclusive of shunting and transfer of traffic." And this is the daily work of two men, not the exceptional labour of any busy period, when press of business would call for extra energy, but what is repeated day by day, week by week, year by year, gradually increasing as the traffic increases, continued without Sunday rest, save in fortunate cases, with only the additional excitement of 18 or 19 hours continuous work instead of 12, when the change from day to night duty is effected once a fortnight.

Take another instance. A signalman of the Midland Railway Company, of fourteen years' standing, looks back with fond regret to one year out of that long period, during which he had no work to do on Sundays, one year in which Sabbath rest was not denied him, but then he often made 8 days a week without extra pay. But with the exception of that fortunate period he has been able to obtain a "Sunday off" only by working on the Saturday and Sunday every other week for 18 hours.

Such are a few of many instances Mr. Bass has selected for publication, to illustrate the dangerous policy of railway companies with regard to their servants. Doubtless the Midland is no worse than any other; from time to time when accidents ensue—the necessary consequence of such a system—the pointsman or signalman inculpated urges overwork as his excuse, and a passing glimpse is obtained of the system; but we have never before had so complete and valuable a statement as that of Mr. Bass. It is too clear, too glaring to be avoided or passed over. The public is made acquainted with its danger, the railway companies reminded of their responsibility, and as a necessary consequence the cause of the overworked servant is ably advocated.

And indeed their cause needs advocacy, for while, on the one hand, continuous responsibilities are thrown upon them, especially on the signalmen and pointsmen, responsibilities which would utterly overthrow the balance of any delicate nervous system, the men are, on the other hand, surrounded by stringent rules and regulations—absolutely necessary it is true—but the slightest infringement of which destroys their hopes temporarily, while neglect, pardonable under most conditions, may in a moment ruin their prospects. Thus, for example, in one of the instances noted, we learn that a signalman obtains a yearly bonus of 2*l.* 10*s.* provided he infringes no regulation, but the fine only of a shilling forfeits this. Imagine how easily this small gleam of sunlight, the only one that ever enters his signal-box, may be blotted out, and judge what must be the feelings of the man who after having striven all he knew perhaps for three quarters of a year, loses the one pleasant anticipation his life has to offer him. Intimately connected with this matter of overwork is the question of pay, which is as disproportioned to the duties required, as those duties are in excess of the capabilities of human brain and strength. From 16*s.* to 23*s.* a week are the wages given to these men, with no allowance for overtime. Their clothes are provided them, one suit a year, for which a deduction of a shilling a week is made from their wages, and—it would be scarcely be believed—the old suit has to be returned before the new one is provided, although at least the full value is paid by the men during the year by the weekly instalments. This may seem but a small matter, but in reality it is not so to a man who is paid scarcely enough to live upon, who is overworked, and who has frequently others looking to him for their support.

The question of wages does not fall so hardly upon engine drivers or guards, who are better paid, and who, especially the latter, make comfortable additions to their salaries by gratuities; the same remark applies to the railway passenger porters. But the signal or pointsman shares none of these benefits, while he takes far more responsibility. He has not even the incitement to care and watchfulness which is owned by the drivers and guards, who, to some extent, guarantee the safety of the passengers under their charge, by their own lives. The signalman is confined to the dreary monotony of his responsible duties, extended beyond all reasonable limits, with the rock of manslaughter always ahead, the chances of fine or dismissal always imminent, and this for wages less than those paid ordinarily for mere dull, mechanical and irresponsible labour.

The interests of the travelling public, and of the servants themselves, alike call for an inquiry into the existing system, while the interests of the railway companies themselves demand also that a change should be made. The strength of a structure is measured by the strength of its weakest part, and it is of little avail that the highest skill and greatest energy should be employed in securing, as far as possible, the comfort and the safety of passengers, that appliances should be perfected, and laws framed for their protection, whilst humble instruments, in whose hands are life and death, should continue to be overworked and underpaid. Of what service is it to strengthen and make secure on every side but one, which is left weak and unprotected? There are hundreds of outlying stations on our main and branch lines where the existing rules of pay and time do not overtax the signal nor pointsman, where trains are few, and duties light; but it is obvious that the conditions are totally changed at the great centres of traffic, and it is at these that a radical change is so urgently required.

It would increase but little the working expenses of any great line, and it would not appreciably affect the shareholders' revenues, were the necessary reforms effected; indeed, with such a change accidents would become less numerous, and yearly liabilities arising from them would decrease; the sums of money paid as compensation for damages sustained would go far towards defraying all the increased expenses incurred in maintaining a proper staff. No signal or pointsman should be kept on duty at a crowded station more than 8 hours, unless in cases of sudden emergency, and no such servants should be employed without a sufficient rate of payment, a rate which would necessarily vary with the district in which he was placed, and the extent of responsibility intrusted to him. With a reduction in the hours of work, and an increase in the rate of wages, the men would become more reliable, and the risks of railway travelling, small as they are, would be still further reduced. The reform so earnestly agitated by Mr. Bass would change injustice to justice, would effect real economy, and altogether raise still higher the present elevated standard of English railways.

THE SEWAGE QUESTION IN PARIS.

M. Alfred Durand Claye, one of the engineers des Ponts et Chaussées, and attached to the municipal service of sewage and water supply, has recently published a treatise on the sanitary improvements of Paris. This work is entitled "Droits, Devoirs et Reformes." The author at first examines the actual situation in Paris from a practical point of view. As a general rule fixed cesspools are employed which are emptied by pumps into carts; 83 per cent. are of this class; 9 per cent. consist only of tubs of wood and are called movable cesspools; and eight are furnished with double cylinders called the dividing system, which retain the solid matters and allow the liquid to flow, the one into a fixed pit, the other into the sewers. The operations of emptying are effected in Paris in a dozen different ways: the matters are conveyed to the municipal depôt of La Villette, whence the liquids are discharged into a sewer some 6 miles long, and the solids loaded upon boats are despatched by canal to the depôt at Bondy. The annual expense of this work reaches in round numbers 6 millions of francs. The deposits are in part treated at Bondy, where they are converted into poudrette and sulphate of ammonia, and the water flows off into the Seine, at St. Denis.

M. Durand Claye has but small pains to show the numerous inconveniences arising from this state of things, the infection in the houses, and in the city, the barbarity of the process, the pollution of the river, the inferiority of the agricultural products.

The situation is better as regards the sewage water. An almost complete system of sewers of large section receives the rainfall, the street and house washings, the liquid mud, and the discharged water of some of the dividing apparatus which flows into them direct. The working of these sewers is satisfactory; but the communication of the houses with them should be established by a system of drains of large section, and already 13,000 houses out of 66,000 have been furnished with this convenience. The sewers discharge their contents into three grand collectors, of which two join near their outfall at Asnières, and the third, that of the discharge water of Bondy, empties at St. Denis. The cleansing of the sewers costs 1,200,000 francs a year, of which the river side districts contribute 170,000 francs.

It will thus be seen that the sewers render to the town, to a great degree, the services that were expected from them; they drain the houses and the streets, they remove from the river, in its course through the city, the deposits that would otherwise pollute it. But there remains to be considered the condition of things down the river below the city. There the situation is most undesirable; the river is full of mud, the water is dirty, and gives out evil odours, and it absorbs an enormous mass of manure, representing an annual quantity of some 1,500,000 tons of fertilising material.

The house scavenging system in Paris is conducted in the following manner: Each night the domestics of the different houses empty a bucket full of the household rubbish before the door. Soon, lantern in hand, come 6000 enrolled chiffoniers, and about 3000 others not enrolled, and called voltigeurs; these examine the heaps of rubbish, turning from right to left the débris, preserving what seems to them worthy of a place in their baskets. Each morning, between 6 and 8 o'clock, 600 wagons pass through the streets, and collect daily from 1100 to 1200 cube metres of rubbish, which are carried either direct to the environs of Paris, or to the banks of the Seine, where it is loaded upon boats. This service costs more than 1,000,000 francs per annum; it presents various grave obstacles to the cleanliness and health of the streets, as well as to the salubrity of the country where the rubbish is deposited, to transform itself by a slow process of decomposition into manure. As some set off, however, the system gives employment to more than 9000 people, and furnishes a useful manure for the cultivation of vegetables around Paris.

Summed up, the present situation of the sanitary condition of Paris is as follows:

The system of sewage removal is deplorable, and costs 6,000,000 francs; the service of sewers is excellent in the city, but creates in the side lands below the town an intolerable condition of affairs, and it entails an enormous loss of fertilising matters. The annual cost is 1,200,000 francs; the scavenging service is insufficient, and costs 1,000,000 francs.

M. Durand Claye presents a complete plan of modifications for these three services, to improve existing conditions and to reduce expenses. The solution that he proposes reduces itself to two essential conditions: 1, an alteration in the system of discharge, with the suppression of the Bondy depôt; 2, the diversion of the direct outflow into the Seine. The second point in effect rules by itself the whole question in this sense, that when the contents of the sewers cease to flow into the Seine, these can receive almost the whole of the sewage. The author of the essay considers that the practicability of this point is already proved; he refers to the trials carried out by Paris, first at Clichy, and afterwards at Genevilliers, with great success, both in the purification of the water with sulphate of alumina, and direct utilisation by irrigation. Long experience shows that cultivators gladly receive the sewage water at all times, and that the means taken for purification are satisfactory. Thus Paris it is urged possesses ample proofs of the method of purifying the Seine, as well as of utilising the fertilising elements of the sewers.

It is argued by this solution of the question, that the cesspools could be suppressed, that the Bondy depôt could be done away with, in a word, that all the inconveniences of the present system would disappear.

This project of utilising the sewage of Paris, in

the plain of Genevilliers, is estimated to cost 10,000,000 francs, the cost of working is reckoned at 1,000,000 francs a year, but the city would be able to levy a light tax on each house closet, a tax one-half of that now charged upon some hundreds on the dividing system, now connected with the sewers, and supposing that this is levied upon 228,000 closets existing in Paris, an annual revenue of 3,420,000 francs would result.

For the improvement of the scavenging system M. Durand Claye proposes the direct discharge of a portion of the débris into the sewers, and a better observation of the rules to regulate the emptying of the rubbish into the streets, and the circulation of the removing carts. It might be sufficient to observe the improvements introduced into this service during the siege of Paris. Such are the suggestions made for the alteration in the sewage system of Paris. They seek to solve the hygienic and municipal problems in a complete manner, to meet at the same time the great agricultural requirements, and to balance the cost of the alterations by an easily gathered revenue. M. Durand Claye devotes a special chapter to prove that these measures would be more regular from a legal point of view, than the actual situation, in which the Parisian Administration in preserving the privileges of the inhabitants, imposes on the riverside population below Paris, and on the district of Bondy and its neighbourhood, constant and grave inconvenience to which they have no right to submit.

LITERATURE.

Modern Breechloaders, Sporting and Military. By W. W. GREENER. London: Cassell, Petter, and Galpin.

"MODERN Breechloaders" is a really important work, one difficult to make complete, but which, when complete, is invaluable for reference, and of great interest to the sporting, military, and general reader. The first part of the book is devoted to sporting breechloaders, and the author observes that to M. Lefaucheux is due the honour of inventing this class of arm. To him also is due the idea of the self-contained cartridge, in order to avoid the escape of gas from the breech joint of the gun. Lefaucheux's plan was simply a drop barrel, secured, but ineffectually to the barrel, by a single grip, which was soon found altogether inefficient; this fault led soon to a host of variations; the sliding action, in which the barrel was forced forward on the stock by a lever; the turn-over action, in which the barrels were hinged in the direction of their axis; the swivelling action, where the barrels turn around a pivot on the stock, about 9 in. in front of the breech. Central fire guns, now so generally adopted in this country, were introduced by Mr. Daw, whose cartridge has undergone but little alteration since he first brought it before the public. The great advantage gained by the central fire principle is the non-escape of gas at the breech. It is clean, it simplifies the action of loading and unloading, and the cartridges are more convenient to carry, and to extract from the gun if required. Of course the central fire guns have, since their introduction, undergone great alterations and improvements—in the attachment of the barrels, in the arrangement of the strikers, the extractors, in fact, in almost every detail. All these details, of which we have not space to attempt any description, will be found explained, and for the most part carefully illustrated in Mr. Greener's book.

A long list of American breechloading sporting guns next claims the author's attention, which together with a chapter upon cartridges, naturally leads up to the performance of breechloaders, and some very practical information upon their manufacture and their management.

As explained in the preface the remarks upon black gunpowder are old, being reprinted from Greener's "Gunnery in 1858;" but of course this does not apply to the sections upon other explosives which since that time have been introduced, or the application of which has been developed since that date. A little more space and more extended information might well have been given in this part of the book.

After an excellent section on breechloading revolvers, the author proceeds to the consideration of military breechloaders, and here we may remark that it is a pity this most important division of the book is not more distinctly indicated, the subheading under which it commences being precisely similar to that of the most insignificant paragraphs. Military breechloaders may be divided into two classes, those which consume the cartridge, and those which extract them; of the former, the Chassepôt and the needle gun are examples; of the latter the Peabody, Martini-Henry, &c.

Foremost in celebrity amongst the first-named class stands, of course, the Prussian needle gun, adopted into the service about 1861, and subsequently experimented upon in this country, but abandoned in favour of the Enfield rifle. Although in the hands of the German troops this weapon has wrought such wonderful results, it appears to be anything but a satisfactory arm. Its gas escape is great, the breech action gets easily fouled by constant firing, the needle is subject to derangement, the consuming cartridge is bad in principle, and must be extracted from the muzzle after a misfire. Moreover, the shooting is not accurate, the range is limited, the rapidity comparatively small, the weight, originally excessive—10 lb.—has been reduced to 11¼ lb. The Chassepôt is open to many of the same objections as the needle gun, of which it is a modification. The barrel is of steel, .434 bore, taking a large powder charge, and the weight complete, including the sword bayonet, is 11 lb. Some minor improvements of detail have been made in the piece, and the range is longer than that of the needle gun, but the gas escape is great, and the fouling excessive.

The Sharp breechloader was one of the earliest and best known American rifles of its class. Adopted at Washington about 1850, it did good service in the Mexican campaign, as well as during the great civil war. Subsequently it became partially introduced into England, some of our cavalry being supplied with carbines; but the gas escape rendered the weapon objectionable. The mechanism consists of a falling block, raised and depressed by a lever, the block being made with a sharp edge that cuts off the end of the cartridge, and exposing the powder to the igniting flash that passes through the block. Subsequent improvements have been, however, made in the construction of this weapon, and metallic cartridges substituted for the linen ones, so as to prevent the escape of gas.

The Westley-Richards carbine, adopted in 1861, was provided with flap breech block, which is raised for the admission of the cartridge, and gets a fair abutment against the breech. This weapon, which has a moderate rapidity, is an extremely serviceable arm, much in favour especially for sporting purposes.

When the English Government decided, in 1864, upon introducing a breechloading rifle into the army to supersede the Enfield, a public competition was invited, to which fifty inventors responded. This number was reduced by inspection to eight, of which the Snider action was finally accepted, and adopted. At once the simplest and most reliable of any system previously known, the Snider rifle has found favour with foreign Governments. In Turkey it has been adopted as the national arm; in Holland and Portugal it is used extensively; the Russian Government has converted a large number of this gun, and the French have introduced a clumsy modification under the name of Tabatiére, not "Tabettier," as Mr. Greener has it.

Of course, a detailed description is given of the principal arms submitted to the investigation of the Small Arms Select Committee, which ended in the recommendation of the Martini-Henry rifle, with the construction of which our readers have been made fully acquainted through the columns of this journal. With some remarks on the shooting capabilities of military breechloaders, on cartridges, and on repeating field guns, Mr. Greener closes a volume in the preparation of which he has laboured arduously, and with much success.

In many instances we should have been glad to see a more detailed description of the mechanism of the various guns noticed, but this would have swelled the volume into almost unreasonable limits, and probably would have exceeded Mr. Greener's intentions, while the engravings which abound, and which for the most part are excellent, help out occasional meagre descriptions.

ADELAIDE POST OFFICE.—A new post office and telegraph station has been completed at Adelaide, South Australia, at a cost of 50,000*l*. It will be seen that the telegraphs have been transferred to the post office in South Australia as well as in Great Britain.

THE IRON AND STEEL INSTITUTE.

THE meeting of the Iron and Steel Institute took place this year at Dudley, where accommodation was kindly afforded in the Dudley Mechanics' Institute, and the museum and rooms of the Dudley Geological Society, situated in the same building, were also placed at their disposal for the accommodation of members. In the theatre a few models were exhibited, the only one of which appears especially to deserve notice, being that lent by Mr. E. B. Marten, chief engineer to the Midland Steam Boiler Inspection and Assurance Company, and consisting of a series of models to scale representing boiler explosions which took place in 1870, selected with a view to illustrate the most frequent causes of boiler explosions, and of seventeen boilers which have exploded during the present year. The first day of the meeting was on Tuesday last, Mr. Henry Bessemer, president, in the chair. The proceedings commenced about 11 o'clock by a short speech from the president. After a brief allusion to the vast amount of interest for which the surrounding district was celebrated, not only from a manufacturing, but also from a scientific point of view, Mr. Bessemer deprecated any attempt to compare the old furnaces to be found here with the newer works which prevail in the Cleveland district. Furnaces in this part took their pattern from some neighbouring works of a very ancient date, and of which it was at one time boasted that they could cast a 15 cwt. cannon once a day. This brief address wound up with a well-deserved compliment to the well-known excellency of the Staffordshire iron. At the proposal of the president, Mr. Head and Mr. Plum were appointed scrutineers to examine election papers for new members.

The first paper read was one by Mr. Henry Johnson, "On the Geological Features of the South Staffordshire Coalfield, with Special Reference to the Future Development of its Mineral Resources." The principal object of this paper, after giving an account of the existing known coalbeds in the locality, and the peculiarity of their sites in some instances, appears to have been to hold out encouragement for the search of new coalbeds at still lower levels, and beneath the new red sandstone. In the present condition of the South Staffordshire coalfields it cannot be denied that the discovery of fresh sources of supply would be highly appreciated, and the advocacy of further research with this object was clearly well-timed and appropriate. All the other papers read on this day had reference to the blast furnace. They were as follows: "A Description of the Ayresome Iron Works, Middlesbrough, with Remarks upon the alteration in Size of Cleveland Furnaces during the last Ten Years," by Mr. John Gjers; "Further Results from the use of Hot Blast Firebrick Stoves," by Mr. Thomas Whitwell; "On increasing the Height of Blast Furnaces in the Midland District," by Mr. T. W. Plum; and "On Mr. Ferrie's Self-Coking Furnace," by Mr. I. Lowthian Bell. Mr. Gjers's paper consisted of two distinct parts, the former part having no direct connexion with the latter. The blast furnaces in the Cleveland district have been continuously increasing in size, and it is justly claimed for the ironmasters of Cleveland that to them is due the credit of having proved that a considerable increase in the size of blast furnaces is practicable. The first specimen furnace selected by Mr. Gjers dates from 1851, in which year three were built by Messrs. Bolckow and Vaughan, of the following dimensions: height, 42 *ft.*; diameter of bosh, 15 *ft.*; and possessing a cubic capacity of 4566 *ft.* The greatest size hitherto attained was reached in 1870, when Messrs. Cochrane and Co. built two furnaces 90 *ft.* in height, 60 *ft.* in the bosh, and of a capacity of 41,149 cubic feet. Those constructed since that date have been of gradually lessening dimensions, and Mr. Gjers is of opinion that the limit of size has now been reached. Mr. Whitwell's paper we publish in abstract on another page, and to this abstract we need add nothing here. The next two papers had reference to the Ferrie furnace, which Mr. Plum considered to be well worthy of some investigation by the Institute. Mr. Plum expressed a doubt whether so much of the saving of fuel attributed to increase of height is really due to the greater height now extensively given to furnaces, whilst Mr. Bell, on the other hand, contended that this increase in height had been attended with economical results. There undoubtedly exists at present important differences of opinion as to the proper dimensions to be given to the inside of the furnace relative to its height, and a certain wildness of design was evident from the 48 sections by which Mr. Gjers's paper was illustrated. These proportions no doubt vary in different districts, with reference to the ironstone or fuel employed, but we would submit that the subject is one well deserving of further elucidation by the Iron and Steel Institute, and the first step towards obtaining the desired information would be the collection of particulars of the results of the working of furnaces of different shapes and sizes under precisely similar circumstances, which can, of course, only be satisfactorily effected by the hearty co-operation of all interested in the subject.

The second day's proceedings opened with a discussion on the papers read the previous day. Mr. Jones, in opening the ball, objected to some of the dates contained in Mr. Gjers's paper, contending that as far back as the year 1859 a furnace was blown in at Cleveland exceeding 40,000 ft. in capacity. Further discussion followed, wherein Mr. Thorneycroft called upon Mr. Bell for an expression of his

opinion as to the benefits derived from a blast of exceeding high temperature, as he had found that when it was raised to 1400 degrees, the last 200 or 300 degrees of heat produced but little benefit. Mr. Williams pointed out that, in blast furnaces, if the escaping gas contains carbonic acid, it is a proof that the operation is being carried on economically, but if carbonic oxide is present, the working of the furnace is wastefully conducted, and he was of opinion that economy of working in furnaces of large dimensions was due more to their increased height than to mere increase of capacity. Mr. Bell contended that the heat of blast in furnaces was really the question of the day, as it involves the question of economy of working, and he expressed his perfect concurrence with what had fallen from Mr. Williams regarding the height of furnaces. When an increase of diameter is given to the furnace without a corresponding increase of height, the effect is merely to cause a derangement in its working; therefore height is a necessary element in any increase of proportions. Mr. Bell was further of opinion that any increase in the heat of the blast beyond a certain temperature was actually detrimental. This discussion was followed by the reading of a paper "On the Nature of the Gases evolved from the Bessemer Converter during the Blow," by Mr. G. J. Snelus, which we publish in abstract on another page. This paper was followed by "A Description of Danks's Rotary Puddling Furnace," by Mr. Samuel Danks. We described this furnace last week, and the subject is one of so great importance, and one in which the Iron and Steel Institute naturally exhibited very great interest. The furnace in question is not very dissimilar to the one with which Mr. Menelaus has for some time past been experimenting at the Dowlais Iron Works, and as that gentleman told the meeting, Mr. Danks briefly explained the difference by saying, "Well, the only difference I see is that I have succeeded and you haven't." The most important feature in connexion with the invention is the lining of the vessel, the method of applying which is described in the abstract of Mr. Danks's paper, which we publish on another page. The discussion which followed the reading of this paper was joined in by Messrs. Fothergill, Williams, Walter Williams, Menelaus, and others, whose remarks fully testified to the importance attached to the introduction of mechanical puddling, even though it was attended by no direct economy from a financial point of view, and a strong feeling was evinced that from the funds of the Institute some expenditure might be made available for putting the question to a practical test. It was, very properly, not thought desirable to set up one of Mr. Danks's machines without first receiving further evidence as to the correctness of the results reported in Mr. Danks's paper to have been obtained in America. The subject was therefore referred to the Puddling Committee with a view to their sending out a commission to America, at the expense of the Institute, for the further investigation of the subject, if, upon mature deliberation, such a course should seem to them most desirable. The discussion upon this paper occupied so much time that it was impossible to take the reading of the two other papers which were on the programme, viz., "On the Newport Puddling Furnace," by Mr. Jeremiah Head, and "On an Improved Heating and Puddling Furnace," by Mr. Howatson. The meeting then closed with the usual vote of thanks to the chairman, and the party proceeded by special train to view the Round Oak Iron Works, by special invitation from the Earl Dudley, concerning which, and the hospitable reception given to the members of the Iron and Steel Institute, we shall have something further to say in another article. The scrutineers reported the names of 42 new members, who have been elected at the present meeting of the Iron and Steel Institute.

NOTES FROM PARIS.

Paris, August 28, 1871.

The New Taxes.

The official journal contains a fourth report of the finance commission on the increase of new taxes and imposts. The report includes, amongst other things, two highly important industrial products, from which it is hoped to derive large revenues; these are matches and paper. The number of match factories in France is about 600, of which 100 are important establishments. The total production rises to the enormous figures of 80 milliards of matches per annum, representing a weight of over 17,000 tons, and a value of 16 millions of francs, wholesale price, but of 36 millions retail price. The alleged motives for supporting this project are: the enormous consumption, the wide margin between wholesale and retail prices, and also the interests of public security, it being considered that a rise of price following the establishment of the tax, would certainly restrict the usage, and consequently reduce the danger of the inflammable materials. The scheme, assuming that the consumption of matches should be reduced to 18 milliards a year, thinks a tax of 5 centimes on boxes containing 100 matches or more, should realise a revenue of 10 millions of francs. The match manufacturers oppose many arguments to the projected tax, and are hardly more disposed to submit to it than were the London manufacturers to the scheme of Mr. Lowe. They appeal to the interests of national industry, to those of the labourers employed, who belong for the most part to the weaker class, that is to say, women, children, old and infirm men, to the interests of consumers, to those of manufacturers, whose labour, capital, and intelligence have developed this industry. They urge that the dangers from fire have increased during some years, and fearing to see their danger increase with the establishment of the tax, in consequence of the necessity that would be created for diminishing the cost of producing, by reducing the care taken in making and packing; they represent that all the raw materials they employ—wood, wax, cotton, stearine, phosphorus, paper, &c., will have to bear already an import tax of 20 per cent. They say that a change in manufacture would be involved, necessitating a change in costly plant; that placing the stamp on the boxes would require an additional manipulation. They maintain that the tax would greatly restrict consumption, would favour fraud, and would not produce the desired results. Some of the manufacturers conclude by demanding that the State should purchase, and carry on the industry, of which it should make a monopoly analogous to that of the fabrication of powder and tobacco. The greater part, however, accepting the principle of the tax, ask only that it shall be far less heavy than is proposed. The commission, adopting the tax in principle, propose a tax of 1.5 centimes on boxes of 50 matches, and under; of 3 centimes on boxes of 100; and of 5 and 10 centimes per box on fancy matches. The estimated revenue from this source is 10 millions of francs.

The paper tax has already been submitted to various modifications. England has had recourse to such a tax in times of difficulty, and has derived large revenues from it. Paper is so universally employed, it renders such varied and numerous services, and its consumption increases daily. Paper offers then a wide field for the levying of taxes, which would be easily collected, because its manufacture is confined to a comparatively small number of important factories. There are in France 438 such works in full activity, producing, collectively, at least 200 millions of pounds per annum. The commission estimates the mean value of the manufactured paper at 100 francs the 220 pounds, and it proposes taxes varying according to the value of the material from 6 to 25 francs the 220 pounds, and anticipates a revenue of 8 millions of francs as the result. The paper makers have not failed to present various objections to the project. The mean value of paper according to them has been so exaggerated that the tax would become far in excess of the price of the fabric; the exportation rises to a considerable figure, and the State consumes nearly one-fifth of the total consumption; they oppose with all their power that which they call an exceptional law, and maintain that the new tax will be but slightly productive, and that it will strike at progress and education indirectly, and that it attacks also many other manufacturers. In this case also the commission yield to necessity, but propose some concessions to meet somewhat the views of the makers.

Agriculture.

The agricultural members of the National Assembly have constituted at Versailles, meetings, in which they discuss questions as specially bearing upon agriculture. M. A. Ronna, a civil engineer of good French reputation, and whose name is known in England by his various works on metallurgy and sanitary matters, has just presented to this society a project for assisting and improving agriculture in the invaded French districts. The author first gives a review of the disasters caused to agriculture by the war in 33 departments invaded or occupied by the belligerent armies. The loss exceeds a milliard of francs, of which animals and agricultural machinery represent a considerable portion. The project has for its object making good this loss. It is based upon credit, but it looks neither to the Government nor to the departments for the money necessary to restore the wasted and impoverished provinces. It is credit from capitalists that is looked for to restore the old condition of affairs. England, who has shown herself so sympathetic in the sufferings of the French peasants, who understands so fully the great interests she has in the agricultural prosperity of France, is ready to furnish to the proposed work the help of her capital, the assistance of her most notable agriculturists, and the patronage of her most important agricultural associations. A company is formed to advance all the necessary capital for the purchase of the requisite plant, grain, &c., and for their transport to the districts. A French society, with a capital of 1,000,000*l.*, is in course of formation, under the patronage of some of the most distinguished men in France. This society will ascertain the requirements of the different agriculturists requiring assistance, will satisfy themselves as to the sufficiency of the sureties offered, and will send the necessary instructions to the syndicate in England, would direct purchases, and would, in short, have the sole responsibility and control in the management. The necessary securities would be given by bodies elected amongst the agriculturists availing themselves of the aid offered, and they would proceed under a law of 1865, passed to facilitate drainage and irrigation works. These securities, authorised and checked by the acting society, would enjoy the departmental guarantee.

M. Ronna presents to the consideration of the agricultural members of the National Assembly the clauses of a proposed Bill, which he wishes to append to the laws of 1869, to promote the carrying out of the combination he proposes. We wish the scheme all success. We believe that it offers at once a good investment, and a speedy and effectual means of repairing the most important damage caused by the war. The combination tends in effect to give to the farmer ruined and helpless, the means once more to restore his position, and, moreover, to give him better means of cultivation than he before possessed.

The Defence of Paris.

We have just received the memoir on the defence of Paris by M. Viollet-le-Duc, ex-lieutenant-colonel of the auxiliary legion of engineers. We hope shortly to refer at length to this most valuable volume.

Railway Steam Ferry.

At Bordeaux, experiments have just been made with a steam flat of special construction that has been placed on the Garonne, to connect the Bartide Station of the Orleans Railway with the Chamber of Commerce Docks, and with the Medoc Railway Station. The considerable traffic existing between these various points has up till now been accommodated by carts which cross the river by the only bridge at Bordeaux, situated about a mile from the docks. This carting, which involves much breaking of bulk, increases the carriage of merchandise by 3 francs a ton. The boat, which has just been built, is intended to transport eight loaded wagons from the Orleans Railway to the rails on the other side of the river. It is of a circular form, and carries 8 radial ways, connected in the centre by a turntable. Two independent engines drive, each two screws, one pair placed at right angles to the other. The one pair produces propulsion, and the other resists the action of the current, and allows, despite its rapidity, the boat to cross the river on the direct line which connects the two points, which are at right angles to the course of the Garonne. The experiments were in every way satisfactory, and the boat is able to follow its course perfectly. The service will be immediately opened.

Mining Explosives.

M. A. Henry, mining engineer, has just published in the *Annales des Mines* an interesting essay on the different explosive substances employed in the working of mines. The author passes in review successively, the ordinary mining powder, gun-cotton, nitro-glycerine, dynamite, dualine, and lithofracteur. He shows the comparative values of those various materials, and allots to each of them the quantity of work due to the workmen, and the work due to the explosion, and the various degrees of security. We extract from the conclusion of the essay the following: If soft and friable rocks are attacked, ordinary powder should be employed, or dualine slightly compressed, and exploded without a capsule if possible. For hard rocks, on the contrary, dynamite or lithofracteur should be employed. In free stone quarries, the two latter substances would be too violent; and equally in the extraction of coal and mineral ores in large bulk. In these cases ordinary powder or dualine should be employed; but in other works, limestone quarries, deep excavations, tunnels, the extraction of poor and hard minerals, driving shafts, &c., it is safe to say that the use of dynamite or lithofracteur is preferable. In driving headings or galleries, no general rule can be laid down, the choice of the explosive must be regulated by the nature and condition of the rock.

Thus if it be water bearing or full of fissures dynamite will give better results than ordinary powder. M. Henry concludes his essay with some just remarks on the inconvenience of the monopoly of powder and other explosives in France, and on the advisability of considerably reducing the tax which hampers the free use of those invaluable aids to industry.

The Suez Canal.

The shareholders of the Suez Canal Company held another general meeting on the 24th ult. They have resolved to effect a loan of 20 millions of francs, intended to cover the two six months' interest due to the holders of shares, and of the two following six months, so as to assure the regular income of the undertaking, until such time as the revenues from working shall become sufficient. M. de Lesseps has furnished the shareholders with various statistics on the steamboat services employing the canal on the progress that is being made in replacing sailing vessels by steamships, on the land winds of the isthmus and on the expenses of working the canal. These expenses will be reduced to 1,500,000 francs per annum, thanks to the economy effected in the organisation of the service.

Ship Signalling.

M. Edmund Martin, of Paris, proposes in a letter to the *Mondes*, the employment on board sailing vessels, of a screw, which shall communicate during the course, the movement to the discs of a magneto-electric machine. The number of sailing vessels is considerable as compared with that of steamers; the employment of electric signals to avoid collisions at sea has become practicable, as proved by the trials made in the French navy, and by the Transatlantic Company. In M. Martin's scheme, a screw is mounted in the ordinary place, this is rotated by the resistance of the water on the blades during the course. This screw, which of course only works during the movement of the ship, drives a magneto-electric machine, and develops a force of from one to two horse power. The irregularities in this motive power can be easily compensated, and besides its special duty, it can be utilised for several other purposes, such as driving pumps, or producing ventilation throughout the ship.

Coal in the Madras Presidency.—Coal beds are believed to exist in the Ellora district of the Madras presidency. Madras has not at present yielded coal, but Dr. Oldham advises a close search.

RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 2437, 6d.) George Henry Ellis, of 20, High Holborn, patents employing, as a substitute for the crank and connecting rod in steam engines, &c., a roller carried by the piston rod, and working in a right and left-hand spiral groove cut in a drum fixed on the fly-wheel shaft, this shaft being disposed parallel to the piston rod. This plan has been proposed before although we are not aware whether any but model engines have been constructed upon it. It, of course, possesses no mechanical advantage over the crank motion, and its application even to very small engines would only be justifiable on the score of its enabling the number of working parts to be slightly reduced. The friction would be much greater than with the crank motion.

(No. 2438, 10d.) Thomas Burt, of Northampton, patents, as the agent of James Burt, of Velsen, North Holland, an arrangement of dredging apparatus which we illustrate on page 134 of the present number, and which we need not, therefore, describe here.

(No. 2444, 1s. 4d.) Walter Robert Kinipple of 1, Westminster-chambers, Victoria-street, patents modes of combining a rising and falling platform carried by parallel motion levers, with a framework forming a sliding bridge, or with a caisson, which can be drawn into or out of a covered recess in a dock wall, &c. We may probably illustrate these plans shortly.

(No. 2447, 10d.) William Barrow Turner, of Ulverstone, George Grey, of Moor Row, and Robert Brydon, of Whitehaven, patent the arrangement of safely cage for mines, &c., illustrated by us on page 297 of our tenth volume.

(No. 2452, 10d.) William Erskine Bartlett, of Edinburgh, patents a form of elastic tyre built up of segments of india-rubber arranged round the wheel and held in place by transverse pins or bolts traversing them and oblong holes in side flanges with which the wheel is provided. The segments are, moreover, encircled by a band of canvas or india-rubber fitted with iron or steel treading pieces.

(No. 2456, 3s. 6d.) Henry Fairbanks, of St. Johnsbury, U.S., patents various arrangements of weighing machines fitted with counting, weighing, and registering apparatus. This is an important specification, but we could not describe its details briefly. We intend, however, to illustrate some of Mr. Fairbanks' plans shortly.

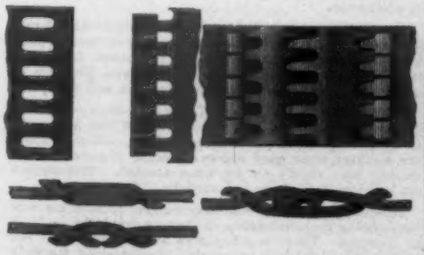
(No. 2463, 10d.) Alfred Vincent Newton, of 66, Chancery-lane, patents, as the agent of George O. Kinne, of Hartford, U.S., apparatus for operating the Gatling gun. We illustrated these plans on page 379 of our last volume.

(No. 2466, 1s. 4d.) George Wells, of North-street, Westminster, patents making earth screws by screwing a spiral flange or disc on to a tapering screw or plug formed at the lower end of the pile, the direction of the thread being such that the act of screwing the pile into the ground tends to force the flange more firmly into its place.

(No. 2474, 1s. 4d.) Lewis Wells Broadwell, of Vienna, patents the arrangements for feeding mitrailleuses, illustrated by us on page 379 of our last volume.

(No. 2491, 6d.) Hamilton E. Towle, of New York, patents the mode of electro-plating the interior of pipes or tubes, of which we published an illustrated account on page 369 of our last volume.

(No. 2495, 10d.) Eli Howarth, of Rochdale, patents ingenious methods of connecting the ends of straps or belts by so cutting one end of the belt that a series of fingers are formed capable of interlocking with holes cut in the other end. The subjoined sketches will explain these plans better than any written description. Simple appliances for



conveniently cutting the straps are also included in the patent.

(No. 2501, 10d.) Peter Murray, of Quebec, patents arrangements of differential pulley blocks. These blocks are fitted with epicycloidal hoisting gear driven by a wheel over which a hand chain passes, and their leading feature appears to be the interposition of a toothed wheel, loose upon an eccentric, between a fixed toothed wheel and the wheels on the pulley over which the chain carrying the load passes.

(No. 2503, 8d.) Thomas Platt, of Paddfield, near Manchester, patents making railway axles in two parts, one part being hollow and being traversed by the other part which is solid. The solid part, which has one wheel keyed on it, is equal in length to an ordinary axle, while the hollow part, on which the other wheel is keyed, terminates against the inside of the boss of the wheel fixed on the solid portion. The solid part is tapered for that portion of its length which fits within the hollow part, while means for lubrication are provided, it being intended that one part shall turn inside the other when necessary to prevent torsion.

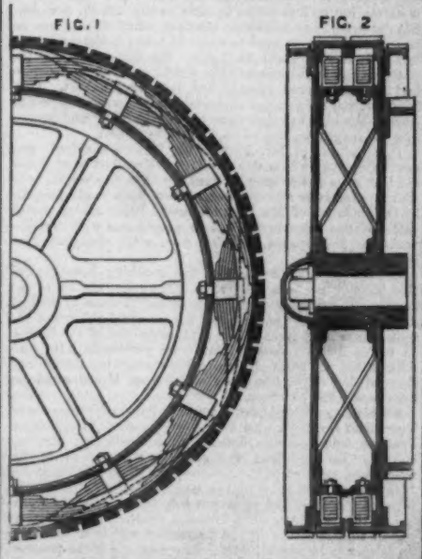
(No. 2507, 10d.) George White, of 68, Cheapside, patents, as the agent of Wilhelm Hacker, of Pola, a form of screw propeller of the class in which a ring carrying propelling blades is united to a boss by helical arms. The patent refers to the particular form and proportions given to the propelling blades and arms, details which we could not explain briefly.

(No. 2512, 8d.) William Alfred Marshall, of Canonbury, patents an arrangement of earth-boring apparatus for use in fixing telegraph poles, &c. The apparatus consists of a hollow stock fitted with a tapered point having a spiral groove cut in it and provided also with an earth screw. One of the main features in the apparatus appears to consist in an arrangement for admitting air down the hollow stock to a point beneath the earth screw, this admission of air facilitating the withdrawal of the screw from tenacious ground.

(No. 2516, 4d.) Gustav Bischof, junior, of Bonn, patents the use of "spongy iron" as a filtering medium for purifying water. We intend shortly to have something to say of this system of filtering which has, we believe, been tested with good results. "Spongy iron," we may remark, is iron which has been reduced from the ore without fusion.

(No. 2537, 1s.) Alexander Melville Clark, of 53, Chancery-lane; patents, as the agent of David Isaac Jones, of Newburg, U.S., what appears to us to be an objectionably complicated arrangement of reversing rolling mill. The specification is worded as if a reversing mill was a novelty.

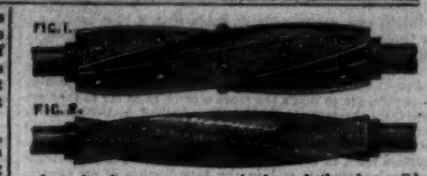
(No. 2542, 10d.) Benjamin Walker and John Frederick Augustus Pflaum, of Leeds, patent a form of elastic wheel for traction engines. In this wheel the elastic bearing surface consists of a pair of loose rings or outer tyres, between which and the rigid inner tyre of the wheel are arranged a series of ordinary plate springs, these springs being so disposed in two rows around the wheel that the centre of one spring comes opposite the adjoining ends of two springs in the next row and so on. The loose rings above mentioned work between side rings, which are attached to the wheel, and which afford a rigid bearing if



the springs are pressed home. The annexed sketch will explain this somewhat complicated arrangement.

(No. 2543, 8d.) Thomas Barnabas Duff, of 10, Laurence Pountney-lane, and Charles Edward Crawley, of 160, Fleet-street, patent a method of forming tunnels by coiling a continuous length of iron or steel bar—by preference of a channel section—into a helical coil of sufficient size. The coils are pressed together, so as to abut on each other, and the abutting flanges of the channel iron may be rivetted together and the joints caulked. We believe that in the majority of cases it would be found far more convenient to make up the tunnel of a series of rings rivetted together, than to employ a helical coil in the manner proposed.

(No. 2545, 6d.) John More, of New York, patents making the cutter heads of wood planing machines with regularly twisted seats, on which correspondingly formed cutters are secured by bolts in such a way as to allow them to be adjusted as they wear, &c. The annexed sketch shows one of these cutter heads. Mr. More claims a number of advantages for his arrangement, and asserts that it reduces the driving power necessary, and enables better



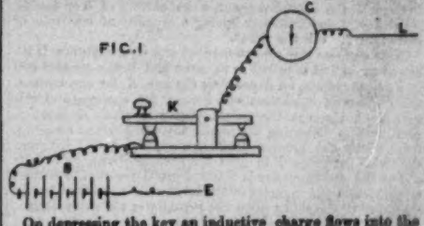
work to be done on cross grained wood than is possible with the ordinary cutters.

TESTING SUBMARINE TELEGRAPH CABLES.

TO THE EDITOR OF ENGINEERING.

SIR,—One of the most important tests to which all well regulated telegraph lines are subjected is that known as the "inductive capacity test." This operation is generally performed in the following manner:

1. The line to be tested, L (Fig. 1), having been insulated at its further end, is connected at its near end to one of the terminals of a galvanometer of known resistance, the remaining terminal of which is connected through an ordinary key, K, to the zinc pole of a battery, B, of 20 or 40 cells. The other pole of the battery is put to earth.

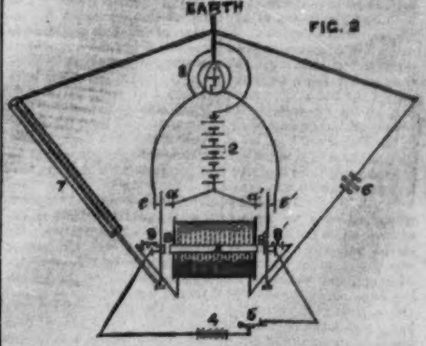


On depressing the key an inductive charge flows into the line violently deflecting the galvanometer needle, unless previously cut out of circuit by a switch. After the lapse of one minute, the switch, which I am supposing to have been used, is opened, and the swing of the needle noted. The inductive capacity of aërial telegraphs under ordinary circumstances is low, and can be measured directly by the vibrations of the needle to which it is proportional. But in the case of underground and submarine lines of any length, the force of induction is much more exalted, and the static charge of such lines will, when allowed to circulate through a galvanometer, drive the needle beyond all readable and reliable limits. In such cases the terminals of the galvanometer are connected across by a shunt of known resistance. A greater or lesser portion of the entire charge is thus diverted from the galvanometer, through the coils of which only so much is permitted to flow as will deflect the needle to a convenient distance.

2. The swing or momentary deflection so obtained is then compared with the deflection which a one minute charge from the same battery will produce on the same galvanometer *unshunted*, and when a condenser of known capacity has been substituted for the line in such a manner that one of its terminals is connected to the galvanometer terminal lately occupied by the line, while the other is joined direct to earth. From the data thus obtained we can calculate, by means of the following formulæ, the value of the inductive capacity of the line in terms of that of the condenser, which is usually made to have a capacity of one mile of the line,

$$(1.)\ \frac{D.C}{d} = s, \text{ or } (2.)\ \frac{\left(\frac{G+S}{S} \times D\right).C}{d} = s$$

D represents deflection of line charge, *d* deflection of condenser charge, C known capacity of condenser, and *s* the required capacity of line in terms of C.



It will be observed by any one conversant with testing operations that the above tests are liable to two or three sources of error, which are amply sufficient to vitiate the results. In the first place, the battery power may alter between the two observations. Secondly, we cannot be certain that the periods of charge, and consequently the charges themselves, are absolutely equal; and thirdly, the deflection of the needle at the moment the charge is allowed to enter the galvanometer is sharp and sudden, and, therefore, unless one has a quick and practised eye it is quite

possible, nay, exceedingly probable, that a mistake of one or two, or even three, degrees more or less may be made in reading off the deflections.

In the apparatus which I have constructed, both tests are taken at the *same* time and by the *same* contacts, the results, therefore, are so much the more correct, in so far as they are free from the errors to which the method just described is liable. The novelty of the invention consists in the peculiar arrangement of the instruments usually employed in induction tests, in the substitution of a double coil for a single coil galvanometer, and in the introduction of an electro-magnetic coil with its accompaniment and actuating battery. Its action is based on the law that when a rapid succession of charges is sent into an insulated cable, the effect on a galvanometer placed in circuit will be to produce a permanent deflection of its needle to an extent which is strictly proportional to the number of charges per given time.

B B', in Fig. 2, are soft iron armatures secured to upright levers by two small screws each. The armatures and levers are supposed to be carefully insulated from each other by inserting slips of ebonite or vulcanite between, and by providing the screws with jackets of the same material. At 8 and 9 are springs to draw back the levers to the contacts, *c* and *c'*, they are permanently connected with the top set of screws on one side, and with the coil of the electro-magnet on the other. The bottom set of screws are connected with the battery, that on the right of the diagram first going to the key, 6. *En route*, 1 is the galvanometer, 2 the testing battery, 3 the electro-magnet, 4 its battery of 3 or 4 cells, 5 the key, 6 the condenser having a capacity of one mile of the cable, 7. 8 is the shunt.

Now suppose the electro-magnet and its armatures, B B', are so made and adjusted as to make and break contact 500 in a minute, then, on depressing the key, K, for one minute, the cable and condenser will receive 250 charges, and will give back through the galvanometer as many discharges, permanently deflecting the needle according to the direction from which the greater discharge comes. In the diagram the cable is supposed to give the greater discharge, and its coil of the galvanometer is shunted until the needle returns to zero, then the capacity of the condenser multiplied by the "power" of the shunt gives the capacity of the cable, thus

$$C' = C \times \frac{G+S}{S},$$

where G is the resistance of the galvanometer coil on the cable side (or half the resistance of the galvanometer, for the two coils are equal) and S the resistance of the shunt.

I respectfully invite the attention of your electrical readers to this method.

I am, Sir, yours truly,

J. J. Fahie.

Persian Gulf Telegraph Department, Jask Station, June 30, 1871.

THE STOWMARKET EXPLOSION.

The inquiry into the circumstances attending the recent explosion at the works of the Safety Gun-cotton Company, Stowmarket, was resumed on Friday morning last. Captain Majendie was again present, and at his request Professor Abel was examined. His evidence referred to the examination of the twenty tons of gun-cotton which were delivered at Upnor, in two lots of 10 tons each, on the 13th of July and 11th of August. The examination was still in progress, but, subsequently to the Stowmarket explosion, the entire store of gun-cotton had been wetted under his superintendence. The whole of the boxes of both deliveries had been opened, and those of the first delivery were found to be apparently perfect; those of the second delivery, however, presented peculiarities on sampling. On examining these samples he found them to be more or less strongly acid to test paper; some of the samples contained considerable quantities of *free* acid, and others a notable amount of sulphuric acid, and were in a dangerous condition. The quantity of acid in the cotton would render it liable to decomposition, which, with the development of heat, would result in spontaneous ignition. If the cotton were confined in boxes in which the heat accumulated, there would be spontaneous ignition. When once a portion of the cotton had become ignited, the remainder would be further heated, and with the concussion of the first portion, exploded, the remainder must explode. The presence of any appreciable amount of sulphuric acid in gun-cotton indicated imperfect purification. Mr. Abel thought the gun-cotton at Upnor, from which these samples had been taken, could not have passed the test at Stowmarket; they had failed to pass the test at his laboratory. There was a large quantity of sulphuric acid, combined with sulphate of lime from the chalk, in the Upnor samples, which ought not to have been present. The sulphate of lime would not have been dangerous but for the free sulphuric acid, for the presence of which the professor could in no way account.

Mr. J. W. Slater, the chemist to the Gun-cotton Company, whose evidence we gave last week, was then further examined upon the details of the testing arrangements. He stated that when a sample of gun-cotton sent for testing was found to be impure, it was sent to be rewashed for 24 hours, and would be sent up for retesting on the following day. Only the successful results were registered by Mr. Baxter, one of the company's clerks, the unsuccessful results being registered in his laboratory only. Carbonate of lime found in excess in the gun-cotton, would induce a suspicion of adulteration; it would weaken the power of the cotton, but would not lead to an explosion. The solubility test was applied to ascertain the comparative strength of the samples, and the heat tests to ascertain their purity. On the 28th of July, a sample submitted to the heat test, fumed strongly at 300°, and exploded below the standard. Free sulphuric acid existed in the sample, which, however, was not the acid in which the cotton was originally dipped, but must have entered the cotton after the dipping and the poaching. Mr. Eustace Prentice gave him the sample of impure cotton on the 28th July, which he understood to have been taken from the driers, and which contained acid irregularly diffused. Had it been part of the original acid which he discovered, he thought it would have been uniformly diffused through the whole substance of the charge. In fact, the acid discovered must have been added since the first test. Mr. Slater agreed with Professor Abel that the Upnor samples were impure, and could not have passed his (witness's) test. No sample in such a condition had ever been sent to him to be tested. He could not explain how the acid got into the gun-cotton sent to Upnor. It was possible for pure gun-cotton to give off fumes at a temperature of 190°, and if the fumes were unable to escape, they might possibly induce decomposition. He did not think that pure gun-cotton would undergo any change in any natural temperature in this climate. He did not think any samples had been passed at a lower temperature than that prescribed by the War Office. He performed all the solubility tests himself, they being the more delicate. The heat tests were applied by his assistant, Mr. Finlay, who, he believed, applied them properly, and whom he considered thoroughly competent. Mr. Slater had subjected cotton, supposed to be well made, to a heat of upwards of 200°, for two days, without inducing any perceptible change. He believed that samples relating to the second delivery of gun-cotton at Upnor were in existence. It was, therefore, arranged, on the suggestion of Captain Majendie, that they should be submitted to the Government chemists for examination.

In continuation, Mr. Slater stated that he had never made experiments to show that acid was equally and regularly diffused throughout the cotton in the poachers. His confidence in the equal diffusion of the acid depended upon his knowledge of the process. Notwithstanding the presence of acid in one charge, no steps were taken to re-test the finished cotton, as the impure charge was supposed to be an exceptional one. His attention was not drawn to the fact that sulphuric acid might be present in the cotton until after the explosion. He then commenced a different series of experiments, and discovered free sulphuric acid in the samples handed him by Mr. E. Prentice on the 28th July. With regard to the cause of the explosion, he thought that acid must have got into the cotton after poaching, and that the explosion was the result of spontaneous combustion induced by the impure condition of the cotton, free acid being present in it.

The next witness was James Smith, who had been engaged in the dipping house for eight years. He spoke as to there having been a little hurrying going on in the works in the washing department for about three weeks previously to the explosion, more cotton having been washed in a given time than usual. The men were employed by the day, no piece-work being done. When work was first commenced, the dippers were expected to dip 75 lb. per day, besides washing, but he had got to be able to dip 125 lb. per day, but did not do any washing. At first, when there were no poachers, the cotton used to stand 48 hours in the acid pots, but now it only stood 24 hours. He did not think the poachers thoroughly washed the cotton, as some bad cotton had been discovered after it had left the poachers. This, however, was only on one occasion and that was a few weeks since. His idea was that some bad cotton had found its way into the magazine, and had led to the explosion.

The evidence of Mr. Finlay, Mr. Slater's assistant, was next taken, and which went to show the method of applying the heat tests to the samples sent up from the works, with which process our readers have already been made familiar by the evidence of Mr. Slater himself. Mr. Finlay stated that the tests were carried out in accordance with the Government instructions, but they were more stringent than those prescribed.

Caleb Turner, the foreman of the poaching house, stated that he had not been hurried in his work. He could not account for the bad cotton sent to be tested about a fortnight since. It could not happen that cotton could get out of the beaters into the poachers, nor could it get out of the beaters on to the driers unless it was done purposely. He considered that the poachers thoroughly washed the cotton, and thought that cotton like the samples from Upnor could not have passed the poachers.

At this stage the proceedings were adjourned for the night. Upon their resumption on the following day, Mr. Eustace Prentice, who had returned from the Continent, was examined. He explained the general arrangement of the works, and referred to the discovery of impure cotton on the 28th of July, which led him to consult his late brother, Mr. Edward Prentice, and to thoroughly investigate the working of the poachers. Mr. Trotman assured him that there was no similar cotton in the magazines, and that there was no danger to be apprehended. The contents of the poacher, from which the impure cotton had been produced, were submitted to another washing. Both he and his brother were of opinion that unwashed gun-cotton pulp had somehow got where it should not have been, but how that was they could not discover. The free acid in the Upnor samples was in excess of that which was found in cotton before it passed the poachers. He could not account for its presence, and could only assume that it had been placed in the cotton, although he had no suspicion of any one having done it. Gun-cotton occasionally inflamed upon the driers, the reasonable cause of which appeared to be that particles of cotton remained on them, having got mixed up with the size used to fix the parchment covers on the mining charges, and becoming gradually decomposed until they ignited at a lower temperature than they ordinarily would. He was quite unable to account for the explosion, except from the scientific evidence which had been given. If even the cotton in the magazines had been ignited by a lucifer-match, he supposed there would only have been a great fire, but no explosion. His impression as to the safety of gun-cotton, except when fired by detonation, was confirmed by the Government experiments. He believed that if the whole of the gun-cotton in the works had been unwashed, it would not have approached the condition of the Upnor samples. Mr. Prentice then referred to the substitution of the brick walls and buttresses for the mounds, which were of timber and earth, considering the former superior to the latter as a protection against fire. He was then examined as to the arrangements for the storage of the acid, and its delivery to the workmen, as well as upon other points in connexion with the details of storing and packing the cotton, and of other arrangements, and in the course of his statement he observed that Professor Abel had no interest whatever in the supplies of gun-cotton to the Government. The royalties received by the professor were 10*l.* per ton upon all cotton manufactured for blasting purposes, and 10*d.* per thousand upon sporting cartridges.

At this point Mr. Merriman, who represented certain sufferers by the explosion, applied for a copy of the license granted by Professor Abel. Mr. Poland, who appeared on behalf of the Gun-cotton Company, objected as Mr. Merriman represented rival interests. Mr. Merriman said he represented persons injured by the explosion, and he had received information from rival manufacturers such as Mr. Webb, a manufacturer of dynamite (Mr. Webb is not a manufacturer but an importer of dynamite into England), but he denied that he represented rival manufacturers.

The remainder of Mr. Prentice's evidence referred to the early manufacture of gun-cotton at Stowmarket upon Baron von Lenk's system; to his subsequent introduction to Professor Abel and the substitution of his method of manufacture, the great feature of which was the beating of the cotton into pulp and then washing it and compressing it into discs by hydraulic power, whilst under the Austrian system of Von Lenk it was made in the form of rope. He then referred to the general principles of the manufacture as lately carried out and to the precautionary measures which were always taken both in manipulation and supervision, as well as in testing, to secure immunity from accident.

At the close of Mr. Prentice's examination the proceedings were adjourned until Monday next, the 4th September.

NOTES FROM THE SOUTH-WEST.

The Strike in South Wales.—At a meeting held at Cardiff on Monday of representatives of the South Wales steam coal colliery proprietors and those of the miners, Mr. Bidder was chosen arbitrator on the part of the masters, and Mr. M'Donald was elected to act in a similar capacity on the part of the men. In consequence of the lengthened duration of the strike, the Pentre colliery has been carefully examined prior to the recommencement of working operations. The workings were found, however, to be free from danger.

Rhymney Railway.—The traffic of this line for the past half-year did not admit of a dividend among the ordinary proprietors, although all the guaranteed and preferential dividends were provided for. The works on the Penalton branch, and on the northern line which is constructed jointly with the London and North-Western Railway Company are now completed, and will be inspected by the Board of Trade in a few days. When the last-mentioned line is opened for traffic, an improvement in the receipts of the railway is anticipated. The contract for the construction of the Taff Bargoed (Dowlais) lines to be made in conjunction with the Great Western Railway Company has been given to a responsible contractor, and the works are now being proceeded with.

The Forest of Dean.—The coal trade in the Forest of Dean shows as much activity as for some time past. There is, however, rather less demand for Forest of Dean iron ore, although there is still a fair amount of employment. The furnaces are as active as ever, and the Forest Vale forge is well employed.

State of Trade at Cardiff.—The close of the great strike in the Aberdare and Rhondda Valleys has induced, of course, a more cheerful feeling in the coal trade. The iron trade continues to display a fair amount of activity.

Penarth Harbour, Dock, and Railway.—The Penarth Harbour, Dock, and Railway Company has declared a dividend for the past half-year at the rate of 4 per cent. per annum. The matters in dispute between the company and Messrs. Smith and Knight have not yet been finally adjusted by arbitration.

Iron Shipments at Newport.—The Abigail has cleared from Newport for New York with 850 tons of iron supplied by the Tredegar Iron Company. The Aunt Lizzie has cleared from Newport for Buenos Ayres with 812 tons of iron supplied by Messrs. Kennard, Brothers, and Company.

State of Trade at Merthyr.—The anticipations entertained in some quarters as to increased activity at the iron works in the Merthyr district have scarcely been realised. There are, however, some good orders in course of execution for railway iron, chiefly on American account. Preparations are being made for large importations of Spanish ore.

Newport Dry Docks.—A large number of men are now employed in the construction of the new dry docks on hand at Newport. There is every reason to suppose that the works will be finished before the time specified for their completion.

Iron for Austria.—The Dowlais Iron Company has forwarded 1430 tons of railway iron to Trieste. The iron was shipped in the Blythwoode screw steamer.

The Gnoll Collieries.—A new engine at the Gnoll collieries continues to work with great success, upwards of 8,000,000 gallons of water being thrown from the pits daily. Soundings prove that there is a general decrease of water throughout the old workings. A large quantity of new machinery has been received and appliances for sinking at the old shafts are being erected.

Welsh Shipping Movements.—The Brage has cleared from Newport for New York with 650 tons of iron supplied by the Blaenavon Iron Company. The Curlew has cleared from Newport for Mollendo with 1634 tons of iron supplied by the

Ebbw Vale Company. The Jennie Armstrong has cleared from Newport for Galveston with 450 tons of iron supplied by the Ebbw Vale Company. The Ceres has cleared from Cardiff for Hamburg with 165 tons of railway iron supplied by Messrs. Guest and Co. The Wasp has cleared from Cardiff for Montreal with 700 tons of railway iron supplied by Mr. R. Crawshay. The Nuovo Rettier has cleared from Cardiff for New York with 900 tons of railway iron supplied by the Aberdare Iron Company. The Caspari has cleared from Cardiff for City Point with 800 tons of railway iron supplied by Messrs. Guest and Co. The Autumna has cleared from Cardiff for Hamburg with 245 tons of iron supplied by the Dowlais Iron Company. The Ocean Pearl has cleared from Newport for Quebec with 1300 tons of iron supplied by the Ebbw Vale Company. The Charles Capper has cleared from Newport for Stettin with 800 tons of iron supplied by the Tredegar Iron Company. The Iroka has cleared from Newport for New York with 1002 tons of iron supplied by the Ebbw Vale Company. The Eliza Aveline has cleared from Newport for New London with 500 tons of iron supplied by the Patent Nut and Bolt Company. The Charlotte has cleared from Cardiff for Norfolk, U.S., with 1052 tons of railway iron supplied by the Rhymney Iron Company. The Ocean Mail has cleared from Cardiff for Galveston with 800 tons of railway iron supplied by the Aberdare Iron Company. The Huron has cleared from Cardiff for New York with 812 tons of iron supplied by the Dowlais Iron Company. The Expounder has cleared from Cardiff for New Orleans with 1000 tons of iron supplied by Mr. R. Crawshay.

Taff Vale Railway.—At the half-yearly meeting of the Taff Vale Railway Company it was stated that connexions were being made to the westward in the Llynvi and Ogmore district, by which it was expected that a large amount of traffic would be brought to the line. Now that the strike among the steam colliers has terminated, the company expects to do a large business. Mr. J. H. Nash has been elected a director of the company in the room of Mr. T. W. Hill, resigned. Mr. Nash was for many years a member of the firm of Messrs. Nash, Cole, and Elton, well known in the iron trade.

Mineral Wealth of the West.—It is estimated that there are in the Bristol district nearly 1,900,000,000 tons of available coal at depths exceeding 4000 ft., and in South Wales alone 4,000,000,000 tons. At depths not exceeding 4000 ft. it is calculated that there are, in the Forest of Dean, 266,000,000 tons; in the Bristol district, 4,218,670,762 tons; and in South Wales, 32,456,208,913 tons.

Brecon and Merthyr Tydfil Railway.—The revenue acquired on this railway in the half year ending June 30, 1871, was 33,870*l.*, as compared with 31,665*l.* in the corresponding period of 1870, showing an increase of 2144*l.* The working expenses of the past half year amounted to 21,323*l.*, as compared with 20,387*l.* in the corresponding six months of 1870, so that the net result of the past half-year's working was an available income of 12,286*l.*, against 11,277*l.* in the corresponding half year of 1870. The company is still unable, however, to maintain as altogether regular dividend service. During the past year the line has been renewed with 750 tons of new rails; another new locomotive has also been contracted for. A balance of 3764*l.* remains available for further renewals. A new passenger station has been opened at Brecon. Matters with the general contractor do not appear to be yet adjusted.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a large attendance on 'Change at Middlesbrough. The market was very firm and closed at last week's rates, viz.: No. 1, 54s.; No. 2, 52s. 6d.; No. 3, 50s.; and No. 4, 48s. 6d. So pressing was the demand for pig iron for immediate delivery, that 52s. 6d. was offered for No 3, in order that steamers loading in the Tees might complete their cargoes and proceed to sea. Every available blast furnace in Cleveland is working to the fullest extent, and will be kept busy over the year.

The Finished Iron Trade.—Bar iron, plate, and angles, and billets, are in great demand. For rails there is less inquiry, but there is still a fair amount of work for the mills throughout the North of England. On the whole the finished trade is in a satisfactory state. There is nothing new to report.

New Works.—The Lackenby Iron Works, at Middlesbrough, are to be opened early in September. At Stockton and Middlesbrough rapid progress is being made with the new works which are being erected.

A New Bank at Middlesbrough.—The York City and County Bank have opened a branch establishment at Middlesbrough. In this growing town, where on account of its being the head-quarters of the North of England Iron Trade, such heavy banking transactions take place, this additional bank will be of great convenience to the commercial section of the community.

A Pier for Redcar.—On Monday the first pile of an iron pier at Redcar was driven by Admiral Chaloner. This rapidly extending sea-side resort has long wanted a pier, and lately a limited liability was formed with a view to constructing one. The requisite amount of capital having been obtained the company communicated with Messrs. J. E. and A. Dowson, engineers, of Great Queen-street, Westminster, who supplied them with an elegant design the erection of which will cost about 6000*l.* Messrs. Head, Wrightson, and Company, have been intrusted with the contract, and the pier which is to be 1300 ft. long will be complete in twelve months. The piles are of cast iron 9 in. diameter sharply pointed at the ends, and are driven by a heavy pile-driving machine into the rock. To these piles will be attached columns placed in pairs 30 ft. apart and battering inwards. Additional stability will be given to the columns by strong wrought-iron bracing. On the top of the columns will be ornamental cast-iron spandrils stretched between each pair of columns. These spandrils will be connected transversely by flooring joints of timber on which the planking of the pier will be fixed. There will be a hand railing of wrought iron on each side of the pier, and at intervals seats will be fitted up for the convenience of visitors. Fixed to the upper railing of the palisading will be 18 gas lamps of ornamental design. The pier will be 20 ft. broad, but at the head it will be widened out to 114 ft. by 65 ft. and a separate landing stage will be placed beyond the head for the landing of passengers from steamers and cobles.

A Proposed Pier for Coatham.—A company has been formed and has obtained power to erect a pier at Coatham, the adjoining watering place to Redcar.

Blyth Harbour and Dock Company.—The ordinary meeting of the shareholders of this company was held at their offices, Newcastle, on Saturday, Sir Matthew White Ridley, Bart., in the chair. The report showed that during the last half year there had been an increase of 18,574 tons in the shipments of coal. Dredging operations are going on satisfactorily, and arrangements are being made for filling Cowpen Slake. A dividend of 5 per cent. on preference shares was declared.

The Nine Hours' Movement.—The agents of the masters have been most active on the Continent, and have procured a fair number of men whom they have despatched to Newcastle-on-Tyne to take the places of the engineers who three months ago struck for the adoption of the nine hours' movement. Altogether, including men from London, Belgium, Prussia, and other countries, about 1000 men have started work in the various factories, but more are expected. This number, however, is comparatively insignificant towards occupying the situations of the 9000 men who struck. But the masters would have been content to have battled on in the hope of gradually inducing some of the old hands to resume work along with the foreigners they were importing. Yesterday the struggle assumed an unexpected phase; a number of Germans at the Elswick Works (Sir William Armstrong and Co.) struck for the nine hours, and declared that they would not resume unless that point was granted. The managing partner of the firm informed them that the "nine hours" would not be granted. In the evening the Germans and other foreigners marched through the streets of Newcastle to the music of a brass band. Although there was a great deal of excitement there was no disturbance. The number of men on strike remaining in Newcastle is now 2181. There are 2828 children. The League state that they are receiving subscriptions from all parts, and have resolved to pay each man 6s. this week, and allow 1s. for every child. The men are more sanguine than ever that they will obtain the movement.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Since this day last week there has been a decline in prices to the extent of about one shilling per ton. The prices last Wednesday were up as high as 63s. 11d. to 63s. 6d. cash, and 63s. 3d. and 63s. 10½d. one month; while yesterday's prices ruled between 62s. 3d. and 63s. and 6d. cash, and 62s. 6d. and 62s. 10½d. one month. To-day's market was rather flat—62s. 9d. to 62s. 7d. one month, and 62s. 4d. to 62s. 1d. cash was taken. Makers were very firm in their quotations at the end of last week, but the firmness is not just so marked at present. The shipments from Scotch ports for last week were not quite so good as they have been for some time back, owing a good deal to the boisterous state of the weather. They are: Foreign, 8395 tons; coastwise, 4190 tons; total, 12,585 tons. Same week last year, 12,528 tons, showing for the first time for a number of months the small increase of 57 tons as compared with the same week last year. The total exports to date are: For 1871, 238,561 tons; till same period last year, 412,507 tons, total increase for year, 126,054 tons. The imports of Middlesbrough pig iron into Grangemouth for week ending August 26, 1871, were 1395 tons; same week last year, 1552 tons, decrease, 157 tons. Total imports for 1871, 54,324 tons; till same date last year, 43,044 tons; total increase for 1871, 11,280 tons. The Monkland Iron and Steel Company finding that Mr. Ferrie's new furnace is giving every satisfaction, are proceeding rapidly with the construction of another upon the same principle, the only difference that it will be plated all over instead of being hooped. When this furnace is finished, Mr. Ferrie expects to heat with the extra gas all his blast furnace engine boiler flues. It is reported that Messrs. Baird and Company are likely to erect some new blast furnaces at Lugar Iron Works in Ayrshire.

The Finished Iron Trade.—The finished iron works were never so full of orders as they are at the present time, and everywhere there is a tone of almost unhesitating confidence. Owing to the scarcity of puddlers and the increasing demand for all kinds of finished iron a large business has been done recently in bringing puddled bar from England, one firm alone having contracted within the last few days to deliver 6000 tons in the malleable iron district. One of the local founders has recently visited Middlesbrough with the view of starting a foundry there for the manufacture of pipes, &c., in order to save the cost of freight on the raw material, and also the extra expense of delivering the finished work in the North of England. In the production of heavy forgings there is an excessive amount of work on hand. The Lancefield Forge Company in this city are actually refusing work, notwithstanding their extraordinary facilities for producing great quantities of work. It is the same in the iron-founding trade. Several Glasgow firms have been unable to take in contracts which they have had offered to them, as, with the other orders in hands, they would be unable to finish them within the specified time. Some of the contracts have been taken up in Dundee and Leith, and there have been persons in Glasgow wishing to engage men. One firm in Dundee wished twenty men, but they are not to be had.

Glasgow Harbour Works—The New Pier at Point House.—The construction of the new pier on the Yorkhill Grounds, Partick, which was commenced in January last, has, since that time, been rapidly proceeded with, and is expected to be concluded in the course of next year. When completed the pier will form a straight line, extending from Point House to the late shipbuilding yard of the Messrs. Connal, and will be more than 1200 ft. in length.

Leith Harbour Works.—The Leith Dock and Harbour Commissioners are about to erect an iron swing bridge at Leith Harbour, to span 120 ft. of waterway, and hydraulic machinery and apparatus for working the bridge. They are advertising for tenders for the construction and erection of the whole works.

Wages of Railway Servants.—On Monday night a large meeting of firemen, brakesmen, &c., employed on the Motherwell section of the Caledonian Railway, was held for the purpose of considering some grievances connected with the department in which they are employed, and also the question of wages. One of the workmen having been called upon to preside, a deputation was appointed to wait upon the locomotive superintendent, Mr. M'Callum. The answer from that gentleman having been considered satisfactory with regard to supposed grievances, the meeting appointed a committee, representing each branch of the department, to confer with the other sections, with the view of uniting in asking the directors for an advance of wages. It is said the men will request equal to 2s. per week.

Exports of Iron Goods and Machinery.—At present there are very great quantities of iron goods and machinery exported from the Clyde. Among recent shipments there have been the following: To New York, 317 tons of rails, and 39*l.* worth of wrought iron; to Rangoon, 3866*l.* worth of machinery, and a steam engine valued at 2500*l.*; to Penang, &c., 2257*l.* worth of machinery; to Montreal, 490*l.* worth of manufactured cast-iron goods; to Lisbon, 180*l.* worth of manufactured iron goods; to Buenos Ayres, 480*l.* worth of railway materials; to Havre, 875*l.* worth of sewing machines; to Porto Rico, 3508*l.* worth of sugar-making machinery; to Genoa, 314*l.* worth of sewing machines; and to Antwerp, 550*l.* worth of sewing machines.

Contract for Two New Cunard Liners.—Messrs. J. and G. Thomson, the eminent shipbuilders, have received orders from Messrs. Burns and Maciver to construct two four-deckers of great size and power for the Atlantic service, and, in addition, an order to lengthen two of their steamships. These orders alone will add upwards of 10,000 tons of steam shipping to the building operations on the Clyde.

Glasgow Support to the Newcastle Master Engineers.—At a meeting of the Clyde Shipbuilders' and Engineers' Association, held in Glasgow yesterday, to consider the propriety of assisting the master engineers of Newcastle and Gateshead, the following resolution was passed: "At a meeting of the members of the Clyde Shipbuilders' and Engineers' Association, and other employers of kindred labour on the Clyde, held within the Religious Institution Rooms, St. George's-place, Glasgow, on Tuesday the 29th of August, 1871, at 2 p.m., called to consider the propriety of forming an association of all employers throughout the country, and the advisability of assisting the employers in Newcastle who have so long resisted the demands of the men who have struck work for a reduction of the hours of labour, it was—after hearing the report of the deputation who had visited the various districts in England, and learning what employers in certain districts had done—unanimously resolved, that the members of the Clyde Shipbuilders' and Engineers' Association, and all others who will agree, subscribe at the rate of one shilling per head of all hands employed by them as a first instalment towards the support of the employers in Newcastle who are resisting the action of the workmen who have struck for 'the nine hours' movement.'"

The Clyde Ship Carpenters and the Wages Question.—During the last few days a large number of the ship carpenters on the Clyde have been on strike for an advance of wages. They wish an advance of 6d. per day, and it seems that Messrs. Tod and McGregor, who have a large repairing trade, have given the advance, but in the meantime the other firms hold out and refuse to grant it. The men are confident that in the present state of trade they will succeed in obtaining what they have asked. Some firms have offered half the amount requested by the workmen.

SOCIETY OF ENGINEERS.—Arrangements have been made for a visit of the members and associates of this society to the Sewage Farm, at Barking, on Monday, the 4th September. Members and associates to meet at Fenchurch-street station, (London, Tilbury, and Southend Railway) at 11.40 a.m. The trains leave for Barking at 11.50 a.m. and 12-7 p.m. Members and associates to pay their own expenses, and may introduce friends.

A RECIPE FOR WORKSHOP USE.—The Registrar-General, in his last weekly report, after speaking of the prevalence of diarrhœa mentions as a valuable adjunct during the epidemic, the following orangeade, suggested by Dr. Waller Lewis, has been extensively used with excellent effects; Sulphuric orangeade useful in cholera times.—Concentrated compound infusion of orange peel, 3 oz.; simple syrup, 12 oz.; boiled filtered water, 4 gals. Mix well and add 3 oz. of dilute sulphuric acid. A wineglassful may be taken for a draught with the addition of more or less of filtered water according to taste. Of this beverage 1360 gals. were consumed with the best effect among the men of the London Post Office during the epidemic of 1866; it superseded to a great extent raw water and bad beer; its cost is only 4½d. a gal. The idea is excellent, as in hot weather men drink anything, and this fluid supersedes noxious waters.

OVERWORKED RAILWAY EMPLOYÉS.

The following letter has been addressed by Mr. M. T. Bass, M.P., to the chairman of the Midland Railway. We have referred to the subject in an article on page 144.

"London, Aug. 9.

"My dear Price,—I have now the pleasure to lay before you a relation of a number of cases of workmen employed on the Midland Railway, of their hours of labour, and their rates of wages. As I explained to you personally, I thought it better to address you in this form than to raise a discussion at your half-yearly meeting before an audience on whose sympathy, from past experience, I would hardly venture to rely.

"I begin with the work performed by John Walker, late engine driver in the service of the Midland Railway Company, from December 5, 1870, to March 4, 1871.

"He was once on his engine 10 hours and 10 minutes; once 11 hours, once 11 hours and 40 minutes, once 12 hours, five times over 12 hours, nine times 13 hours, three times over 13 hours, three times 14 hours, three times over 14 hours, three times 15 hours, three times over 15 hours, four times 16 hours, eight times over 16 hours, five times 17 hours, four times over 17 hours, once 18 hours, twice over 18 hours, once 19 hours, once 20 hours, once 22 hours, once 23 hours, once 24 hours, once 28 hours.

"These particulars, I am assured, give a general view of the work performed by engine drivers during the winter months of 1870-1, for proof of which I refer you to the time books at the engine sheds at St. Pancras, Bedford, Wellingboro', Leicester, Derby, Toton Sidings, Nottingham, Sheffield, Leeds, Bristol, Gloucester, Saltley, &c.

"Guards have been worked even longer than drivers. I have had communication with several who have been from 18 to over 40 hours with their trains, and with some who have been with special and other trains for a whole week without having their clothes off; for proof of which see guards' time sheets at Bristol, Gloucester, Derby, Birmingham, &c. And many, while performing this extra work, have had no extra pay.

"I have corresponded with many pointsmen, who state that they have to work 12 hours a day, with no time for meals, but are all day long at their points and signals, and when not attending to passenger trains they have the points to reverse and signalling to attend to for goods trains, light engines, and shunting, &c. They have been so oppressed with excessive work as to be unable to perform their duties efficiently, with due regard to the safety of the public or the interests of their employers.

"I have learnt that at one of the boxes near Leeds from 200 to 220 trains passed during the 24 hours, each train having to be entered in a book nine times. During the 24 hours the beats on the bells "give and take" 6038 times; beats on the needles "give and take" 6150; levers to pull over, 464. This is exclusive of shunting and transfer of traffic.

"This enormous amount of work and oppressive responsibility is imposed on two men with salaries, I am informed, of 22s. a week each. May I not ask whether the work required is not excessive and the wages totally inadequate to the duties required?

"I have a statement from a signalman in the following terms:

"'I hold the responsible and dangerous position of a signalman. I have to stand 12 hours a day on duty. I have not time between the passing of trains to get a meal of food; that is out of the question. I have to eat my food with one hand while I attend to my points, signals, and block telegraph with the other hand for seven days a week, while at 'change day,' from night to day service, once a fortnight, I have to stand at work 18 or 19 hours for the sum of 20s. 3d. per week, and some of my comrades, working seven days a week, only get 18s. 3d. The common porters work from 16 to 19 hours per day for 15s. 5d. per week, with some little addition for overtime; but for the least mistake we are then severely fined. How do you suppose a man with a family is to live on 15s. 5d. per week—4s. 6d. or 5s. house rent, &c.?'

"Here follow extracts from letters from different servants on the Midland line:

"'July 21.—I have held the responsible place of signalman or pointsman under the Midland Railway Company, and have been in the service as porter for over five years, and never had a Sunday to myself, only the Sunday I get off for my week's leave of absence, and then I am stopped payment for that time; and now I am holding the responsible place of pointsman, with seven levers to work and the block system, as well as other work, for a wage of 18s. per week, and have been making 14, 15, and sometimes 16 hours per day, and nothing extra. I have begun my duty at 7 in the morning until 11 and 12 at night, and no one to come and relieve me; and after I have done signalling, I have to walk half a mile in both directions to put the lights out, and have not even a top coat allowed.'

"'I have been under the Midland Railway Company nearly 14 years, and during that period have not known what it is to have a Sunday off, unless I have worked on the Saturday and Sunday every other week 18 hours, with the exception of one year, when I was fortunate enough to have no Sunday work, but then I often made eight days a week and got nothing extra for it. My wages are now 21s. per week; I began with 16s. I am allowed 2l. 10s. per year bonus, if I am fortunate enough to get it, but if I am only fined 1s. I lose the bonus for that year, and I have to struggle on for another. I am allowed one suit of clothes per year, but we pay for them at the rate of 1s. per week, and when we have paid for them they actually order us to bring them in when we are supplied with another suit. Twelve hours are too long for any man to be shut up in a box, where he has to get his meals as best he can.'

"'We have 12 hours night and 12 hours day duty, and I can say with a clear conscience that I have not time to eat my meals or sit down. We average about 200 trains in 24 hours, beside engine shunting and piloting every minute. We have on our hands all this responsibility for the sum of 18s. per week of six and a half days. I have been running about with my dinner in my hand, putting it down and taking it up, and biting at it like a dog. I have put it on the shelf over my work frequently, and bite and sup until it is finished.'

"I have in my possession a great number of cases of a similar character, but enough has, I hope, been said to insure your attention to questions of so much gravity.

"I will conclude by quoting from the *Times* of Monday, August 7, a part of the cross-examination in the case of Oliver Merritt, who was charged with the manslaughter of Miss Kirkpatrick at Unstone, on the Midland line. It was proved that he worked as pointsman 13 hours every day but Saturday, when he worked 15 hours, and every alternate Sunday, for 17s. a week. Let me ask, is it possible for a man to perform properly the responsible and dangerous duties of pointsman for so many hours, and is it reasonable to expect that well-qualified men will undertake such duties for 17s. per week? I was not surprised to hear from the superintendent of police at Derby that he has recently had twenty applications from pointsmen on the Midland Railway for situations in the police force, because they say their occupation is so dangerous and their wages so inadequate.

"I count confidently on your receiving this communication in the same earnest spirit which prompts me to address it to you.

"I propose to send this letter to the newspapers, and I request your permission to do the same with any answer you may be so good as to send me.

"I am, dear Sir, yours very truly,

"M. T. Bass.

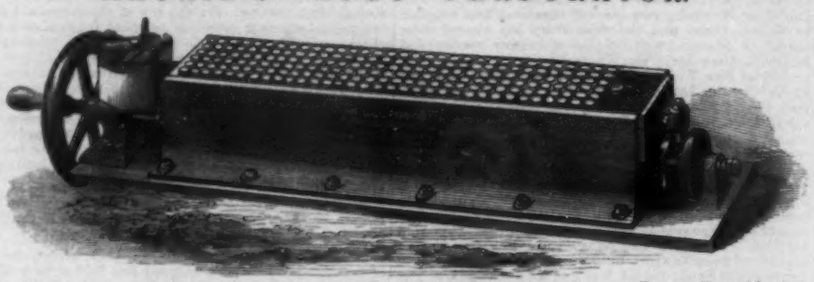
"W. P. Price, Esq., M.P., Chairman of the Midland Railway Company, Derby."

MACKIE'S PERFORATOR.

About three months ago we described in this journal (*vide* page 335 of our last volume) the very ingenious type-composing machine shown in action at the International Exhibition by the inventor, Mr. Alexander Mackie, of Warrington, and we now illustrate an important adjunct to that machine also designed by Mr. Mackie. It will be remembered by those of our readers who studied the construction of the type-composing machine, that the action of the type selecting mechanism of that machine is governed by the position of certain perforations made in a continuous slip of paper which is run through the machine, and which thus serves much the same purpose as the Jacquard cards of a loom. These slips of perforated paper used to be prepared by a perforating machine having sixteen keys like those of a piano, but recently Mr. Mackie has designed the improved apparatus which we now illustrate.

We may remind our readers that each slip of paper above referred to is perforated with seventeen rows of holes, the central row being continuous and serving the purpose of a rack by means of which the slip is advanced step by step through the machine, while the eight rows on each side of it are discontinuous, only such holes being punched as are required to designate the letters or words which it is desired that the composing machine should set up. We may also remark that it is one of the distinctive features of the composing machine that it sets up whole words at once, a transverse row of holes in the perforated paper almost always corresponding to an entire word or syllable. These things being premised we may proceed to explain the perforator we now illustrate.

Referring to the engraving it will be seen that the apparatus consists of a kind of box traversed from end to end by a spindle which can be turned by hand or steam power. Within the box are nineteen plates placed one above the other with a small space between them, and each of them capable of sliding longitudinally in suitable guides. The top and bottom plates of this series are connected together at one end, the connecting piece being provided with a roller which works between cam plates on the revolving spindle already mentioned. By this means, as the spindle rotates, a slight longitudinal to-and-fro movement is imparted to the top and bottom plates of the series which the box contains. Each of the sliding plates is pierced with six rows of holes, there being thirty-three holes in each row, and through each of these holes passes a piston which is kept pressed lightly upwards by a spiral spring placed on it. Each of these pistons is made to fit closely, but freely, the holes in the top and bottom plates through which it passes; but the intermediate portion of its length lying between these plates is turned down to a smaller diameter, one or more thin collars of a diameter corresponding to that of the holes being, however, left at intervals. These collars are so situated on the piston that when the latter is in the raised position in which the spring tends to maintain it, any collar or collars with which it is furnished will come between the sliding plates.



MACKIE'S "LOGO" PERFORATOR.

It thus follows that, although, as the top and bottom plate move to and fro all the pistons are carried with them, yet so long as these pistons are in their raised positions, no motion is communicated to the intermediate plates. When a piston is depressed by a finger being placed on it, however, the case is altered. On a piston being depressed the thin collars with which it is furnished instead of lying between the sliding plates are brought into a line with them, and as these collars fit the holes in the plates, the sliding motion of the top and bottom plates is communicated to those intermediate ones to which the collars on the piston which is depressed corresponds. Supposing, for instance, that a piston is provided with collars which, so long as the piston is raised, lie between the 2nd and 3rd, the 10th and 11th, and the 15th and 16th plates, respectively, then on the piston being depressed, the 3rd, 11th, and 16th plates will be made to participate in the motion of these at the top and bottom, and so on. It will thus be readily understood how, by varying the positions of the collars on the pistons, and by depressing more than one piston at a time an almost endless series of combinations can be produced.

We must now speak of the arrangement for perforating. Referring again to the engraving it will be seen that the paper to be perforated is fed forward intermittently by an arrangement of rollers at one end, and successive portions of it are thus brought opposite a set of seventeen punches, disposed in a vertical line, and respectively attached to the ends of the seventeen intermediate sliding plates already referred to. It will thus be seen that when certain plates of this series are caused to move longitudinally by the depression of one or more of the pistons, the punch belonging to them produces corresponding perforations in the paper slip. Five rows of pistons give a sufficient number of combinations to produce the perforations corresponding to the setting up by the composing machine of 600 common words, while the sixth row gives the whole English language. The whole arrangement is an exceedingly ingenious one, and Mr. Mackie deserves great credit for having obtained his desired result by such simple means.

Mr. Mackie has also lately produced another modified arrangement which we should notice here, and which has been thus described. "Over the top of a row of punches is made to pass a series of 'logos' made of zinc, each representing a letter, word, or sentence. In their passage they actuate the proper punches, so as to secure the exact number of letters and spaces in any line required. It works at the rate of 450 letters a minute, and will be three or four times that speed for Mr. Mackie's 40,000 an hour compositor. The ordinary workman will soon learn to pick up these 'logos,' which are about the size of advertisement rules, and in cases laid much in the ordinary way. Speed, however, can only be secured by the workman using combinations, which he may increase to any extent. Each 'logo' represents 3½ letters on the average. It is astonishing how accurately Mr. Mackie's plan secures 'justification.' So many 'logos' weigh exactly the length of type required, and can be varied to a thin space."

Calcutta Municipality Fire Brigade.—The steam engines made by Messrs. Merryweather and Sons have been selected in preference to those of other English and foreign manufacture for the Calcutta Fire Brigade. The facility of management by others than experienced engine drivers, accessibility to all parts of each machine in the event of repairs being required, and general simplicity of the engine, gained universal approbation, hence the selection.

London Association of Foremen Engineers and Draughtsmen.—On Saturday, the 26th ultimo, about 150 members and friends of this institution paid a visit of inspection to the Crystal Palace. They were received by Mr. James Rowley, chief engineer to the Palace company, and subsequently conducted by him through the various engine-rooms and pump-rooms of the establishment. Afterwards a collation was served in the large dining hall to the visitors.

The Coast Railways of Northern Germany.—The gaps which have hitherto existed in the coastal railway system of Northern Germany are soon to be filled up, and the whole net rendered as complete as possible. The construction of the line from Tilsit to Memel will be commenced this year, and when it is finished the completion of the direct railway from Bremen to Hamburg will only be wanting to place Memel in uninterrupted railway communication with Emden, which will be a great advantage both in a commercial and a strategical point of view. Besides this, the railways from Bremerhaven to Cuxhaven, and from the latter town to Stade and Harburg are to be completed in the next two years. The construction of these lines stands in connexion with the whole system of coastal defence, which is to be completed by the end of the year, 1873.

BAUSCHINGER'S INDICATOR EXPERIMENTS ON LOCOMOTIVES.

(*Continued from page* 117.)

(*d*) *Expansion.* The action that takes place in the cylinder during the period of expansion is of special importance for the purpose of comparing the various theories respecting the action of the steam in an engine. The essential differences of these theories consist solely in the application of several hypotheses respecting the relative pressures and volumes of saturated steam. The results of practice show, however, a marked discrepancy between the theoretical curves of expansion and the actual expansion line drawn by the indicator, and in order to investigate this circumstance, Professor Bauschinger has selected two curves taken from the hind cylinder end of engine (A). These diagrams, which are reproduced in Figs. 23 and 24, are taken with the reversing lever in the first and fourth notch respectively; in one case Fig. 23, 70 per cent. of water, and, in the other diagram, 40 per cent. of water.

As shown by the diagrams, the departure of the actual curve from the theoretical curve of expansion is very considerable, and much more than the deviation of the various theoretical curves amongst themselves. In stationary engines, also, the indicator bears witness to a similar difference existing in a greater or less degree. In order to investigate the facts which we have just considered, Professor Bauschinger proceeded in the following manner: From a number of indicator curves, taken at different degrees of expansion, the mean absolute pressure behind the piston was first measured and then compared with the mean absolute pressure of admission, the expansion curve having been continued to the end of the stroke. The figures thus obtained are given in column D of Table IV. According to the law of Mariotte, the same relation of pressures is calculated by the following formula:

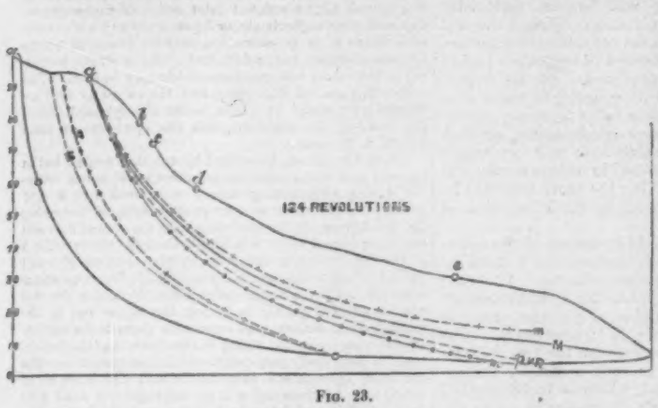


FIG. 23.

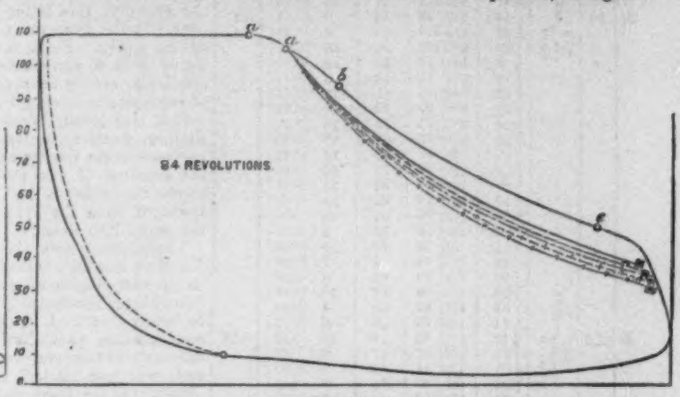


FIG. 24.

$$\frac{l_1}{l} + 2.3026 \frac{l'_1}{l} \log \frac{l'1}{l'_1},$$

where l_1 = distance travelled by piston during the period of admission, and l = total length of stroke, including clearance space. The results calculated by this law, which also shows a nearer approach to the actual performance than the other theories, are given in column E of Table IV., while column F of the same table contains a coefficient obtained by division of the two preceding columns. A comparison of the effective pressures will be of more

TABLE IV.

A	B	C	D	E	F	G	H	I
Class of engine.	Notch.	Period of admission in per cent. of stroke.	Ratio of mean pressure behind piston and mean indicated pressure during admission, in per cent. of pressure at admission.	Ratio of mean pressure behind piston and mean pressure during admission according to Mariotte in per cent. of pressure at admission.	Comparison of columns D and E $\left(\frac{D}{E}\right)$	Ratio of mean effective pressure and indicated pressure during admission in per cent. of pressure at admission.	Ratio of mean effective pressure and mean pressure during admission according to Mariotte in per cent. of pressure at admission.	Comparison of columns G and H $\left(\frac{G}{H}\right)$
A	1	16	60	59	1.20	29	19	1.53
	2	23	69	60	1.15	43	33	1.37
	3	32	77	69	1.12	50	42	1.19
	4	58	84	81	1.04	60	57	1.05
	5	47	87	86	1.01	64	63	1.02
	6	55	91	90	1.01	69	68	1.01
	7	61	93	92	1.01	73	72	1.01

practical value, and accordingly the mean effective pressures of the same indicator curves were measured and compared with the mean pressure of admission. These results are contained in column G of Table No. IV., and by subtracting them from those in column D, we obtain the mean pressure before the piston in per cent. of the average pressure of admission; this coefficient again subtracted from column E, gives the mean effective pressure according to Mariotte. Finally, column I of Table No. IV. compares the results of columns G and H, and, as will be noticed, the actual performance of the engine is considerably above that of the theoretical power, thus, with a period of admission of 16 per cent. of the stroke, the work exerted, as shown by the indicator, is over 50 per cent. above the law of Mariotte.*

Instead of comparing in this manner the expansion curves of all the eight engines, the following simpler proceeding was employed. In each indicator curve were marked, from the distribution diagram, the beginning of expansion and release; the absolute pressures corresponding to both were then measured, and their relative ratio ascertained. As will be noticed, these values, which have been computed in Table No. V., are very constant for the same degree of expansion; we have selected, for the purpose of comparison, the two engines A and E, as they illustrate a greater difference of pressure, between the beginning and the end of expansion. We stated above that the expansion of the steam, according to the law of Mariotte, is such that the pressures are in the inverse ratio of the spaces occupied at the beginning and the end of expansion respectively. This ratio is given in Table No. V. as the true ratio of expansion, taking into account also the clearance spaces; it amounts to 0.26 and 0.18 respectively, while the ratio of the corresponding steam pressures is 0.42 and 0.28 respectively. In the same measure, also, the actual curve, as drawn by the indicator, will be above the theoretical curve laid down by the law of Mariotte.

Finally, the following Table, No. VI., contains the mean ratios between the initial and final pressures during the period of expansion for various degrees of suppression. Here, again, a material difference will be noticed between the true ratio of expansion and the corresponding pressures; the amount of departure of the actual pressures from the theoretical curve bearing, however, a certain relation to the degree of expansion, as will be seen presently. There are various causes which produce this action during the period of expansion, but their precise influence is more or less difficult to ascertain. In the first place, leakage at the valves or past the piston is, of course, calculated to alter the actual expansion curve. In the engines experimented upon by Professor Bauschinger, the valves and cylinder faces were accordingly examined, but they were found not only in good condition but perfectly bright, so that no leakage could possibly have taken place; moreover, the effect of leakage, if such occurs, is generally easily detected by the irregular form of the indicator curves. The main cause of the peculiar action of the expanding steam is due, as the experimenters observe, to the heat given off by the cylinder to the contained steam after its communication with the boiler has been cut off. This condition is facilitated by the presence of a certain quantity of water, which, at

the suppression of steam occurs, according to the distribution diagrams, at 14 per cent., and in the other case at 33 per cent. of the length of the stroke. In these diagrams the theoretical curves are laid down according to the laws of Redtenbacher, Mariotte, Rankine, and Zeuner in the following manner:

1. Redtenbacher, agreeing with Pambour as to form, calculates the pressures of steam corresponding to different relative volumes, or the ratio between the volume (V) and (V_0) and the pressure (p) and (p_0) of expanding steam, by the formula $p = \frac{V}{V_0}(0.284 + p_0) - 0.284$, where p and p_0 are expressed in atmospheres of 14.706 lb. to the square inch. The expansion line, obtained by this theory, is drawn in the diagrams (Figs. 23 and 24) by a dotted line (– – – – *p*).

2. According to the laws of Mariotte, the pressures are inversely as the volumes, or $\frac{p}{p_0} = \frac{V_0}{V}$. The curve constructed after this formula is shown in the diagrams by a continuous line (———— M).

3. Rankine assumes that the expanding steam receives from the cylinder a certain amount of heat, sufficient to maintain its saturated state. The resultant curve has been calculated by the aid of Zeuner's tables of the properties of saturated steam, and is shown in the diagrams thus (–.–.–. R). In Fig. 23 this line coincides with the dotted expansion curve.

4. The theory of mechanical heat, established by Zeuner, is based on the hypothesis that the expansion of the steam takes place without loss or gain of heat from any external source, or $\frac{V}{V_0} = \frac{uX + q}{u_0 X_0 + q}$, where u and u_0 = the specific volumes of the expanding steam, q = the specific volume of the water, and X and X_0 = the quantities of saturated steam contained in a unit of weight of the expanding steam. The lines marked (–o–o–o *u*) in the diagrams have been constructed under the supposition that the steam was in a perfectly saturated but not surcharged state at the beginning of the expansion, or $X_0 = 1$. The other lines (+–+–+– *u*), on the other hand, correspond to the case of the steam contained, in the case of

* We have given in the text the results arrived at by Professor Bauschinger, but, after a careful examination of the indicator diagrams to which he refers, we cannot but arrive at the conclusion that, in some cases, at all events, the "distribution diagrams" employed by him did not represent the action of the valve gears with the accuracy which was desirable. The diagrams shown by Figs. 5, 6, 7, and 8, on page 52 of the present volume, are striking instances in point. The deduction we should be inclined to draw from a comparison of these diagrams with the corresponding distribution diagrams would be that there was a certain amount of looseness in the valve gear for which the last-mentioned diagrams made no allowance, and that hence the points of cut off and exhaust were both later than Professor Bauschinger has assumed them to be. A similar error would account for at least a portion of the discrepancy between the results deduced from Mariotte's law and those of actual practice, to which special reference is made above.

Table V.

Class of engine.	Period of admission in per cent. of stroke.	True ratio of expansion.	Reference number of diagram.	Number of revolutions per minute.	Pressures above the atmosphere in pounds per square inch. In boiler.	At beginning of expansion.	At end of expansion.	Ratio of absolute pressure.	Mean ratio.
			15a	142	116	102	34	0.42	
			14	125	114	103	33	0.41	
			11	147	115	89	28	0.41	
			27	134	98	90	28	0.41	
			12	119	94	84	26	0.41	
			13	124	117	103	34	0.42	
			29	136	106	76	23	0.42	
			30	132	111	70	21	0.42	
			26	120	85	73	21	0.41	
			28	140	83	73	23	0.43	
			39	134	105	65	18	0.45	
			41	117	111	54	14	0.42	
A	10	2.76 =0.38	40	147	88	43	9	0.41	0.42
		10.57	43	115	114	50	4	0.42	
			23	120	107	98	33	0.42	
			8	149	72	49	14	0.45	
			4	144	71	53	6	0.44	
			18	146	92	51	12	0.41	
			10	139	90	70	21	0.42	
			6	137	71	51	14	0.44	
			16	137	73	65	17	0.40	
			15	133	80	59	16	0.42	
			18	129	85	73	25	0.45	
			20	126	93	82	25	0.41	
			19	122	73	65	20	0.44	
			16b	148	86	81	10	0.26	
			15	121	80	73	9	0.27	
			14	83	77	71.5	10	0.29	
			24	173	78	67	7	0.27	
			30	172	78	64	6	0.26	
			23	109	86	74	10	0.28	
			38	197	62	50	4	0.29	
			22	169	66	10	—6	0.27	
E	12.6	1.945 =0.18	32	167	85	78	10	0.27	0.28
		10.776	36	155	57	47	2.5	0.28	
			31	144	81	69	9	0.29	
			35	132	83	65	8	0.29	
			30	179	58	41	3	0.32	
			34	169	70	9	—8	0.29	
			40	159	71	22	—5	0.27	
			35	156	69	14	—7	0.28	
			37	204	58	45	2.5	0.30	

Table VI.

Class of engine.	Number of notch.	Period of admission in per cent. of stroke.	True ratio of expansion.	Number of indicator curves taken.	Ratio of pressures at beginning and end of expansion.	Nature of work.
	1	10	0.26	14	0.42	Goods train
	2	23	0.33	5	0.46	,,
A	3	32	0.40	11	0.52	,,
	4	38	0.52	10	0.57	,,
	5	47	0.59	1	0.62	,,
	1	10	0.37	11	0.48	Passenger train
B	2	26	0.43	18	0.53	,,
	3	34	0.49	8	0.58	,,
	4	44	0.58	1	0.64	,,
	3	36	0.50	4	0.55	Express train
C	4	42	0.54	7	0.63	,,
	5	49	0.59	6	0.63	,,
	2 hind	14	0.27	14	0.40	Goods train
	2 front	27	0.39	14	0.47	,,
D	3 hind	21	0.34	40	0.47	,,
	3 front	35	0.46	40	0.52	,,
	7 hind	53	0.62	3	0.66	,,
	7 front	66	0.70	2	0.70	,,
	1	12.6	0.18	17	0.28	Express train
E	2	15	0.20	8	0.34	,,
	5	21	0.26	5	0.39	,,
	3	29	0.34	5	0.42	Goods train
F	4	36	0.42	12	0.48	Passenger train
	5	47	0.52	9	0.53	,,
	1	20	0.34	15	0.41	Goods train
G	2	30	0.43	7	0.49	,,
	3	57	0.60	17	0.62	,,
	1, II.	13	0.21	2	0.27	Mixed train
	2 ,,	21	0.28	4	0.35	,,
H	3 ,,	30	0.38	7	0.42	,,
	4 ,,	38	0.45	5	0.48	,,
	5 ,,	43	0.50	4	0.51	,,

the commencement of the expansion, has the temperature of the live steam, but as the pressure is reduced in the cylinder, this water will be instantaneously evaporated, and thus abstract from the cylinder a certain amount of heat. The heat absorbed with such rapidity is sufficient to raise the pressure considerably above that which would have existed had no condensation and re-evaporation taken place (see also curves of the theory of mechanical heat in diagrams Figs. 24 and 24). The amount of heat which can be so absorbed depends, of course, upon the difference of temperature between the steam and the metal. On the other hand, the mean temperature of the cylinder is influenced by the amount of protection against radiation and conduction of heat from the cylinder, by the amount of "throttling" from the boiler to the cylinder, by the extent to which expansion has been carried, and by the speed in revolutions per minute.

When the communication between the boiler and the piston is open, the cylinder will acquire a temperature practically the same as that of the boiler pressure, and if the cylinder contained nothing but dry or superheated steam, this temperature would probably be maintained for the greater part of the stroke; but owing to a certain amount of water which has been deposited in the cylinder, and which is re-evaporated at the expense of heat imparted to the cylinder, this latter will become materially cooled by the time the piston has reached the end of the stroke. From these considerations the relative effect of various degrees of expansion and of speed will readily be appreciated. As the degree of expansion is increased the quantity of water converted into steam becomes also greater, necessitating, however, a larger condensation of high pressure steam during admission; and the longer the duration of the stroke, in other words, the slower the engine is working the more heat will be absorbed from the cylinder by the conversion of this water into steam.

The influence upon the temperature of the cylinder of various meteorological causes was felt during the greater portion of the experiments. Professor Bauschinger recommends that the cylinders should be better protected, in order to prevent excessive condensation, particularly in winter time. The difference of temperature between the two cylinder ends was also marked, in most cases, by the indicator; at the front end, which is badly exposed to the currents of cold air, the indicator curve was generally of a more depressed character. The foregoing considerations lead to the conclusion that in order to gain the full benefit of expansive working it is essential to combine the element of high speed with some arrangement to prevent the condensation of steam during the admission. As it is, the cylinders of a locomotive are not sufficiently protected against the influences of the atmosphere and the chilling action of strong currents of air; the employment of superheated steam would be one mode of preventing condensation, but the same end may be better effected by the use of steam jackets. At all events, with a better protection of the cylinders against loss of heat, a direct gain in the power exerted by the engine, or a corresponding economy in respect of consumption of fuel, would be the inevitable result.

(To be continued.)

WOOL SCOURING AND DYEING.

Some very efficient appliances for facilitating the processes of wool scouring and dyeing have been recently brought into use at the Prospect Wool and Cloth Dyeing Works, Huddersfield, and by the courtesy of the proprietors, Messrs. Ensom, Spence, and Co., we have been permitted to make a careful examination of the whole arrangement, and witness the operations carried out from beginning to end by Mr. Richard Heppenstall.

The intention of Mr. Kirkham, the inventor, has been well carried out by Mr. Melling, of Rainhill, the engineer to the company, who has fitted up the machinery, and the ease and precision with which one man, or even a boy, can control all the movements that are required, while he remains quietly seated, would surprise those who have been accustomed to think that the old-fashioned method of "stanging," as the hand process is technically called, is the only one that would rightly carry the wool through all its varied courses till completely dyed.

In addition to the "stanging," the usual way of operating, involves much labour in the removal of the wool from pan to pan, and considerable waste of materials, as well as great loss of heat, all of which are largely rectified by the newly patented plan.

The wool during its treatment in the various liquors requires pretty continual turning over or "tossing" to insure the whole of the fibres becoming equally and uniformly impregnated, or cleansed, as the case may be, as it must not be allowed to become matted.

To do this by the ordinary "stanging" process one or two men use a kind of pitchfork with a long and strong wooden handle, with which, and by the exertion of great force, they drag the wool up from the bottom of the pan as best they can, and stir it or toss it about in the liquor, using the handle as a lever, resting it upon the edge of the pan or vat as a fulcrum. The wear and tear shown upon the edge of the vat indicates clearly that this work is no slight matter. This work is also very trying, as the liquor is kept on the boil by a fire below all the time the process is being carried on. But we will now describe the new arrangement.

The new engine consists of one steam cylinder, which is single-acting only by steam. It is placed vertically, and is closed both top and bottom. The piston rod passes upwards through a gland in the top cover, and is attached to a heavy cast-iron weight, to force the piston to make its down, or suction stroke, after the steam has raised it to the top. The upward stroke being the one by which the main work is done, is performed by the steam. The cylinder used is about 34 in. diameter, and 34 in. stroke. The valves are actuated by very simple cam-shaped tappets, placed upon a vertical spindle, with which there is a communication from the working platform, so that by hand the position of the tappet may be varied as is required. The engine is self-acting when started, but is still under perfect control. It works but slowly, making three ar four double strokes per minute, with about 40 lb. steam pressure. It is provided with a series of inlet and outlet passages, so that either atmospheric air, or liquor from any vat or tank with which it is in connexion, may be drawn in on the downward stroke, and be delivered by the up stroke, according to the valves and passages which may be open. The connexions are all 4 in. pipes, and the valves to each are conveniently placed in a line, under the eye, and within the reach of the attendant, who can open one or more valves, as he pleases.

About 40 vats can be worked by one such engine, but in the case now under consideration there were but four scouring, dyeing, and washing vats of wood, each 7 ft. 6 in. × 6 ft. × 6 ft., and three or four smaller ones, for preparing the dye liquors, the former being upon the ground floor and the latter placed about 6 ft. higher than the others. Each of the dye vats has a cold water supply; a steam pipe and valve leading to the bottom for boiling the liquor by steam from the boiler; a large outlet valve, by which the vat can be emptied quickly by letting the liquor run to the main drain or stream; and connexion pipes to the engine. But another important fitting to these vats is a false bottom made of iron, finely perforated, which is so placed near the bottom of the vat, and there firmly held, that when air is forced into the space below it by the engine, it shall produce a certain and determined action upon the liquor, &c., which may be contained in the vat. The proper fixing of this plate has been a matter of considerable difficulty, as an imperfect action might either roll the wool into lumps, or perhaps leave the corners unmoved.

Having thus described the general features, let us notice the process followed out with a bale of wool:

No. 1 vat is filled with water, say 1700 gallons, and the steam is turned on to warm the water, during which time one of the workmen puts into the vat the scouring ingredients, which, according to the nature and condition of the wool, are judged to be necessary. This differs much from time to time, and needs the careful attention of the person in charge of such work, under whatever system it has to be treated. Then the engine is set to work with the air suction valve open, and the first discharge of air which takes place on the up-stroke of the piston, is passed into the bottom part of the vat, under the perforated plate, through which it rises through the whole volume of water, which it disturbs and turns about, like a wave of the sea rushing over a rough and rocky shore. Two or three such strokes, discharging air under a pressure, as indicated by the pressure gauge, of 25 lb. per square inch, serve to thoroughly mix the liquor and all the chemical substances which have been put into it. The air finds its vent naturally from the surface of the water, and has done its work. When this preparation has been made the bale is cut open, and the wool is lifted by two men into the vat, either entire or in portions, as is most easy to them. The engine is again made to pump air into the vat, and ten or twelve strokes suffice to thoroughly shake out the wool, and drown it in the liquor, as though it were rags in a paper maker's rag-engine. Steam is now admitted, and the liquor is made to boil freely till the oily character of the wool is wholly removed by the perfect washing action, imparted to the contents of the vat by the intermittent discharges of air from the engine, which, by its beautiful action, continually tosses the wool and the liquor in every direction without throwing it out of the vat. The scouring liquor thus used is not, however, entirely exhausted of its chemical properties, and being hot is now allowed to run off to vat No. 2. The vats being on one level are soon equally full, and the engine is then, by a change of valves, made to draw off the liquor remaining in No. 1 vat, and to deliver it into No. 2, where it only needs to be strengthened by the addition of some fresh scouring materials, and No. 2 vat is ready to receive a bale of wool to be treated as that in No. 1 has been, meanwhile the first bale of wool still remains where it was in No. 1 vat. It now needs washing or rinsing to free it of all the scouring materials. This is done by a rapid supply of cold water, and a pretty frequent tossing by air from the engine. When washed enough, in one or more waters, which are run off to waste, the wool is ready for the next process, which, in the operation we witnessed, was that of "chroming." This chrome liquor is admitted to the vat from one of the preparing cisterns, which are placed at the

higher level, and it is diluted with water, and boiled up with steam, as the attendant sees necessary, while at the same time the engine is made to toss the whole about, as in the previous parts of the work. After this "chroming" has continued its proper time, the former operation of passing the liquor to another vat is repeated, and the wool in No. 1 is left once more; this time it is ready for the logwood dye for making it black, or for any other colour, for which the previous process has left it fit. The dye liquor is supplied hot from its preparing cistern, as was the case with the chrome liquor, and when done with, it is in its turn also passed on to another vat, to be strengthened and used again, and so on. The wool is now ready for removal from the vat in which it was first placed, the process being complete.

It will have been noticed by the reader that there is little or no waste of heat in such an arrangement as this, and also little or no waste of dye liquor. Each quantity being passed on, from one vat to another, hot, and ready with a little help of new stuff, for repeated operations. The saving thus obtained is really a very important item, and deserves careful attention.

The result of the whole is, that the work can be turned out at a considerably reduced cost, notwithstanding the outlay for machinery, while at the same time a much greater uniformity of colour can be produced, and with greater evenness throughout the whole batch of wool under treatment than by the ordinary method.

There is also a special chemical action in this system of dyeing, which has much to do with the good result, arising from the extra quantity of oxygen that is imparted to the dye liquor from the blowing and tossing by compressed air, which is of great importance in the work.

The arrangements patented for the tossing by air are such that they need not involve entirely new plant, but can be added without difficulty to any of the ordinary vats or pans now in use, thus rendering the application of the new system one within the reach of any person desirous of reducing the heavy hand labour of his works as far as possible. No doubt there will be some who have long been used to the old-fashioned way of working who will raise objections, but so far as we could learn from those practical dyers with whom we spoke, on the occasion of our visit to Messrs. Heppenstall's works, the greater portion were induced to look favourably upon the arrangement, and to predict for it a considerable amount of success.

TECHNICAL EDUCATION.

In an appendix to the prospectus of the Royal Rhenish-Westphalian Polytechnic School at Aix-la-Chapelle, the directors of that establishment publish a series of instructions to those who wish to become students. These are so complete, so excellent, and so practical, that we have thought it worth while to reproduce them, reserving our comments upon them for another occasion.

The Council of the School state that they are frequently asked for advice—

1. With respect to the admission of those students who have not obtained the necessary qualifications by previous attendance at the first class of a gymnasium or commercial school of the first order.*

2. With respect to the manner in which the required qualifications are best obtained by those young men who have still a few years to wait before either age or other circumstances will allow them to attend a polytechnic school, but who are either unable or not desirous to attend during this time the schools mentioned above.

3. With respect to the manner in which the necessary studies are best regulated for those who are destined in the future to carry on any practical business, and who, without wishing to become thoroughly qualified engineers, architects, or metallurgists, are desirous of acquiring, besides a commercial education, and the knowledge of a speciality of trade, a general technical and scientific education.

4. Finally, with respect to practical training or working; whether the students should work in the shops before going to the Polytechnic School, or whether it should be postponed until the theoretical education at the school is finished.

If the following remarks should fail to give satisfactory advice for every special case, they will at least enable the public to decide generally on the best course to be adopted, and to frame their inquiries for special cases in such a manner that the council will be able to give a prompt and decided reply.

Qualification and Preparatory Education in General.

No greater mistake can be committed in the education of a young engineer or manufacturer than to send him too early into the workshop for practical labour. An efficient general education is to-day the chief condition for passing successfully through technical or scientific studies, and the time spent in acquiring fundamental knowledge is fully compensated for by a more rapid progress, and a more thorough understanding of all mathematical and technical studies. A neglected education is always the cause of subsequent incompetence, and largely influences that freedom of thought which so much facilitates the acquisition of those qualifications which, besides technical knowledge, are necessary to a successful career for the engineer and manufacturer. It is true that many excellent engineers, with an inferior early training, have performed great things, but it is quite certain that they could, and would, have done more with great ease had they been properly educated.

Special Preparatory Education for Attending a Polytechnic School.

Those young men, whose means and time will allow them to do so, should, therefore, attend a gymnasium or commercial school of the first order, and should pass through the upper classes of these schools. Pupils of gymnasia should take into consideration that a knowledge of foreign languages (especially French and English) is of the greatest importance to the engineer, and those who are backward in mathematics and linear drawing should devote extra hours of study to those branches, gaining help from older pupils of the polytechnic, for students who are unable to follow the course of lectures during the first half year are easily discouraged. The first year at a polytechnic school is generally admitted to be the most difficult and most important for the student, and it demands the greatest perseverance and closest attention.

Those who have been unable to attend for their preparatory education one of the qualified schools, should acquire by means of private lessons or studies such knowledge as is required for entering the superior classes of qualified schools. If in those cases a partial knowledge of the dead languages is no disqualification; a thorough acquaintance with elementary mathematics and drawing is on the other hand indispensable for attending with success the lectures on higher mathematics, descriptive geometry and mechanics; no student can be admitted who does not possess the knowledge of the first principles of physic and chemistry. Those who wish to pass the necessary examination (required from all who have no certificate from a qualified school) for admittance to the Polytechnic School at Aix-la-Chapelle at the beginning of October in each year, will have an opportunity of completing and improving their knowledge by attending during the summer preceding the examination, and by following the lectures on elementary mathematics and mechanics, given and held for that purpose at the Polytechnic.

The Practical Education in the Shops.

The question whether a young man who intends to study, not only exact sciences (mathematics and natural philosophy), but who also proposes to become a practical engineer (mechanical or civil), should acquire his practical education before or during the course of his theoretical education, is not easily answered. The age of the student, his health, means, and general situation, his habits and position, have all to be taken into consideration.

It is generally admitted to be very useful to work during one year in the shops before attending a polytechnic, so long as the theoretical knowledge already acquired is not only preserved during the time, but improved and strengthened. A year in the shops will be, besides, of great benefit for those who are bodily weak and mentally overworked, and if the practical work is followed earnestly it makes the student punctual in his habits, mechanically precise, and practical. The greater independence and practical knowledge derived from these labours are of great value for following theoretical studies, which appear easier, and which can be pursued in a more practical manner.

It has thus to be taken into consideration whether the young man has the means for devoting one or two years to the shops with little or no remuneration, whilst, if after a couple of years' abstract study, he should give a similar time in the workshop, resuming the former for a year or two, he might expect some compensation during that time for being occasionally employed in the drawing office.

Experience has shown, however, that if a young man goes into the shop in the midst of his studies with the intention of completing his theoretical education after some years' practical work, this intention is not often carried out, for there students soon obtain a certain practical position, for which they are amply paid, and which opens new prospects for them, that they feel disinclined to relinquish. But the consequences are unfortunately felt when it is too late, and then the regret is great that they did not finish their theoretical education at the proper time; much time, energy, and expense are then required to obtain the necessary knowledge, and it happens generally that such men occupy an inferior place with respect to their scientific training.

The working in the shops *after* the theoretical education has been completed, offers generally an early opportunity for earning wages, but these pupils are so often taken away from the shops and sent into the drawing office as cheap and extremely useful assistants, that they cannot derive the desired advantages for the course of practical training, because sufficient time is not left to them to become thoroughly acquainted with the use and application of tools and materials. The students themselves are generally not free from blame in this respect, for they are, as a rule, not too ready to go through the ordinary and laborious shop-work. Not many young men possess the necessary energy to assume the mechanic's dress after having completed their theoretical education, and to work for two or three years at the lathe, vice, and in the erecting shop, or to take the trowel or axe into their hands. Such an occupation appears to them the more useless as it often happens that able young engineers become thoroughly competent men in their profession without having passed through any course of practical training.

Mechanical engineers who intend to follow locomotive engineering would do best to work, after having finished their studies, in the shops of a railway for about two years, and then and before entering the drawing office to learn the driving and management of the locomotives. After having passed the examination as engine drivers they are soon taken away from the office and put into positions as assistants or district locomotive superintendents. Otherwise it happens very often that pupils who leave the shops for the office without having passed the examination as engine driver, postpone the stipulated training time for the latter, on account of the great hardships and inconveniences connected with it, and they themselves thus put obstacles in the way of quick promotion.

The early or preparatory education of a student has also a certain influence. A youth who has lived in a small town, and who has spent all his time over his studies without having opportunities of forming practical opinions, should not come to the polytechnic without having worked for some time in the shops. Those again whose parents or guardians are manufacturers, engineers, or practical tradesmen have often occasion to form opinions, and get practical knowledge during the time of their attending school; they often hear at home the discussion of practical questions, and they will find less difficulty in attending the lectures at the polytechnic, even if they come direct from the school without having previously worked in the shops. Civil engineers and architects will therefore do best to learn the handicraft of a building profession for about two years before entering the polytechnic. Mechanical engineers should work for the same length of time in an engineer's shop, where they have an opportunity of getting different work to do, and where they could form an opinion of the general arrangement and management of engineering works. Two years of work in the shops are generally sufficient for a young man with a good preparatory education, but it will be of no use, and a waste of time to spend these two years in the office of an engineer only, and perhaps during that time only make tracings or copy manuscript. Of course all these recommendations cannot refer to those young men who intend to enter the services of Government. Special laws are published for them by the different departments of the Government.

The best course to be adopted for mining engineers and practical chemists is certainly to complete entirely their theoretical education at a polytechnic school before entering on practical services. The mining engineer when leaving the polytechnic derives the greatest advantage from learning, during one or two years, the details of his calling, whilst those who are to be employed as analytical chemists after leaving the polytechnic, will mostly remain thoroughly acquainted with only one or two specialities, and they will consequently find difficulties in obtaining in the future important and independent positions as directors or managers of works and mines.

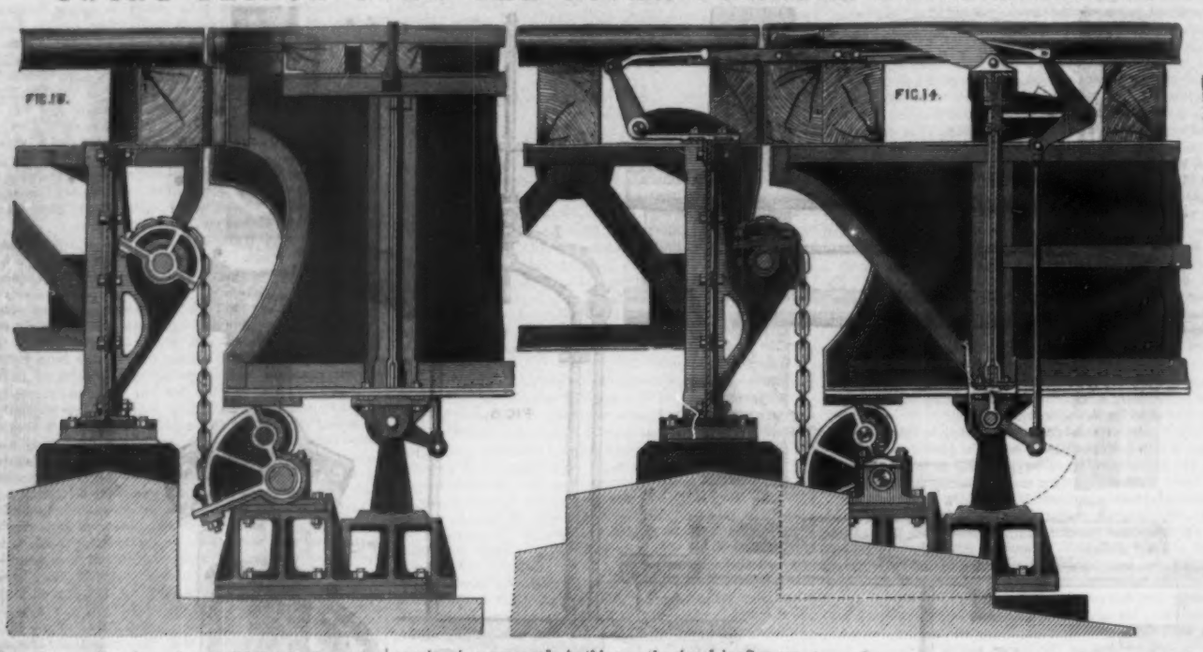
Theoretical Education of Manufacturers.

Young men who intend to enter into any industrial business or profession without becoming thoroughly qualified engineers, but who wish to undertake the management of manufacturing works ought to obtain both a technical and a mercantile education, and they should therefore regulate their studies according to the branch they have chosen, without, however, neglecting those studies which are a general preparation for any technical training. Physics and chemistry, mechanical technology, descriptive mechanics and drawing belong to these studies, and it is a great mistake if, for example, one who studies for a technical chemical branch (dyeing, manufacture of glass, starch, sugar, gas, beer, &c.), should believe he could be independent of mathematics and drawing, or if another for a mechanical technical branch (manufacture of cloth, spinning, weaving, &c.), he should think the knowledge of chemistry is of no service. It is absolutely necessary for pupils studying for any particular branch of industry to attend the selected lectures during one year, whilst a study during two years, especially for the chemical technical branch will be amply sufficient for acquiring such knowledge as might be useful for any branch of manufacture. Those students are, however, deceiving themselves who believe that they may acquire a thorough knowledge of any special branch of industry, for example, silk weaving on power looms, by attending the polytechnic school for a short time without having obtained previously a general technical education. No specific is imparted at the lectures, and trade secrets have no place. The polytechnic does not furnish ready-made practical men for any special branch of industry, but it puts the students in a position to become such men in a short time, and to obtain the necessary knowledge for acting independently. A student must not expect that a professor should arrange his lectures for his special branch of study, and lecture, for example, upon the application and use of wool, at greater length and with more minuteness than upon other subjects; such a course would be unjust to other students. A detailed knowledge of the details of a special branch of industry can only be obtained at the works and not at the school, where only principles are taught, and where a student learns the scientific reasons why anything is done, so that he may be saved the labour of going over old ground, and solving problems that others have already solved before him.

In conclusion we must repeat once more that the general rules for admittance to the polytechnic require the certifi-

[* Certificates from these schools are required in Prussia for almost every branch of Government or other services, and are obtained by most young men of the middle classes; certain privileges for the military services are besides connected with these certificates, which are considered altogether necessary as proofs of a finished education.—ED. E.]

SWING BRIDGE OVER THE RIVER PARNITZ NEAR STETTIN.



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The bridge we illustrate has two equal spans as regards the position of the piers, 40 ft. each, and a central or turning pier of 25 ft. diameter; the bridge is situated between two river piers 12 ft. wide, and carries a double line of rails. The whole length of the superstructure is 117 ft. The pivot bolt is in the centre, and the transverse distance between the main girders is 18 ft. When the bridge is shut, each main girder is supported at three points, which form two spans of 58 ft. 6 in. and 54 ft., as the turning point is placed 3 ft. from the centre. At the opening of the bridge the outer support of the longer span is lowered, when the bridge is carried by the pivot and three rollers; the counterweight is 20 cwt., so that the pressure upon the central roller is about 100 cwt., but some means should be adopted for regulating the exact height of this roller. The two other rollers are provided with springs, which limit the pressure on these rollers to 5 tons per roller, and which give full elasticity during the traffic. Any irregular movement during the opening of the bridge is prevented, so long as the pressure on each roller does not exceed the amount mentioned; this is effected by bearings through which the spring presses against the cross girder below with a force of 5 tons, so that the spring is prevented from acting before the roller receives that pressure. The load for calculating the strength of the structures has been assumed as 40 cwt. per foot run; 7½ cwt. of this load are taken up by the weight of the structure. The maximum tensional strain of the iron is 5 tons per square inch.

The pivot bolt, which has a diameter of 4¼ in., has to withstand a maximum strain of 85½ tons; it is made of cast steel, and turns in a cast-steel socket; the casing into which the pivot bolt is fixed by means of screw threads is also made of cast steel. The adjustment is effected by turning the bolt from the top, and the wheel shown in the drawings serves to fix the exact position. Three adjustable cast-steel guide blocks, fastened to the socket, procure the circular motion at the lower part of the casing, and in order to enable the step bearing from underneath the pivot bolt to be removed when the bridge is firmly shut, the socket is made in several parts. These parts of the mechanism are placed, however, between the plated sides of the cross girders, and for this reason they are very difficult of access, to obviate this inconvenience, a simpler form of construction has been proposed, in which the position of the pivot bolt is fixed, whilst the step bearing above is adjustable from below by means of a cottar or wedge.

The mechanism at the movable supporting end of the bridge is shown in Figs. 13 and 14; it consists of three parts, namely, the lifting apparatus, the support, and the shutting and signalling apparatus. The superstructure of the bridge, when turned towards the piers, rests on the pivot pin and the rollers, and the lifting apparatus is used for raising the end of the bridge to a height of about 5 in. The power required for effecting this increases uniformly in proportion with the distance raised, and becomes finally equal to the pressure of the unloaded bridge upon the supports and the counter-weight. On lowering the supporting points, a reverse condition of things takes place.

If the total lift, therefore, is δ, and the pressure upon the supports, P, the pressure, after a distance, α, has been lifted, is $P\frac{\alpha}{\delta}$; and in order that during this operation the friction only may have to be overcome, a descending counterweight, Q, has to be so arranged as to always maintain the pressure $P\frac{\alpha}{\delta}$, in equilibrium. The distance through which this counterweight has to travel, is determined by the equation of virtual moments, $P\frac{\alpha}{\delta}d\alpha = Q\,dy$, where $d\alpha$ denotes the momentary lifting of the end of the bridge, and dy the corresponding descent of the counterweight. This condition is fulfilled if the load, $\frac{P\alpha}{\delta}$, ascends with uniform velocity on a quadrant of the radius, r, whilst the load, Q, descends on a semicircle of the radius, R. During the rise of $\frac{P\alpha}{\delta}$, the angles formed by the movement with a horizontal line are measured, and during the descent of Q, those with a vertical line. For if the end of the bridge is raised as much as $\alpha = r\sin\alpha$, the counterweight descends by the amount $y = R(1-\cos B)$, and as $B = 2\alpha$, $y = R(1-\cos 2\alpha)$; $dy = 2R\sin\alpha\, d\alpha = 4R\sin\alpha\cos\alpha\, d\alpha$; and $d\alpha = r\cos\alpha\, d\alpha$, we get:

$$\frac{P\alpha\, d\alpha}{\delta} = \frac{P r^2 \sin\alpha\cos\alpha\, d\alpha}{\delta} = Q\,dy = Q.4R\sin\alpha.\cos\alpha\, d\alpha,$$

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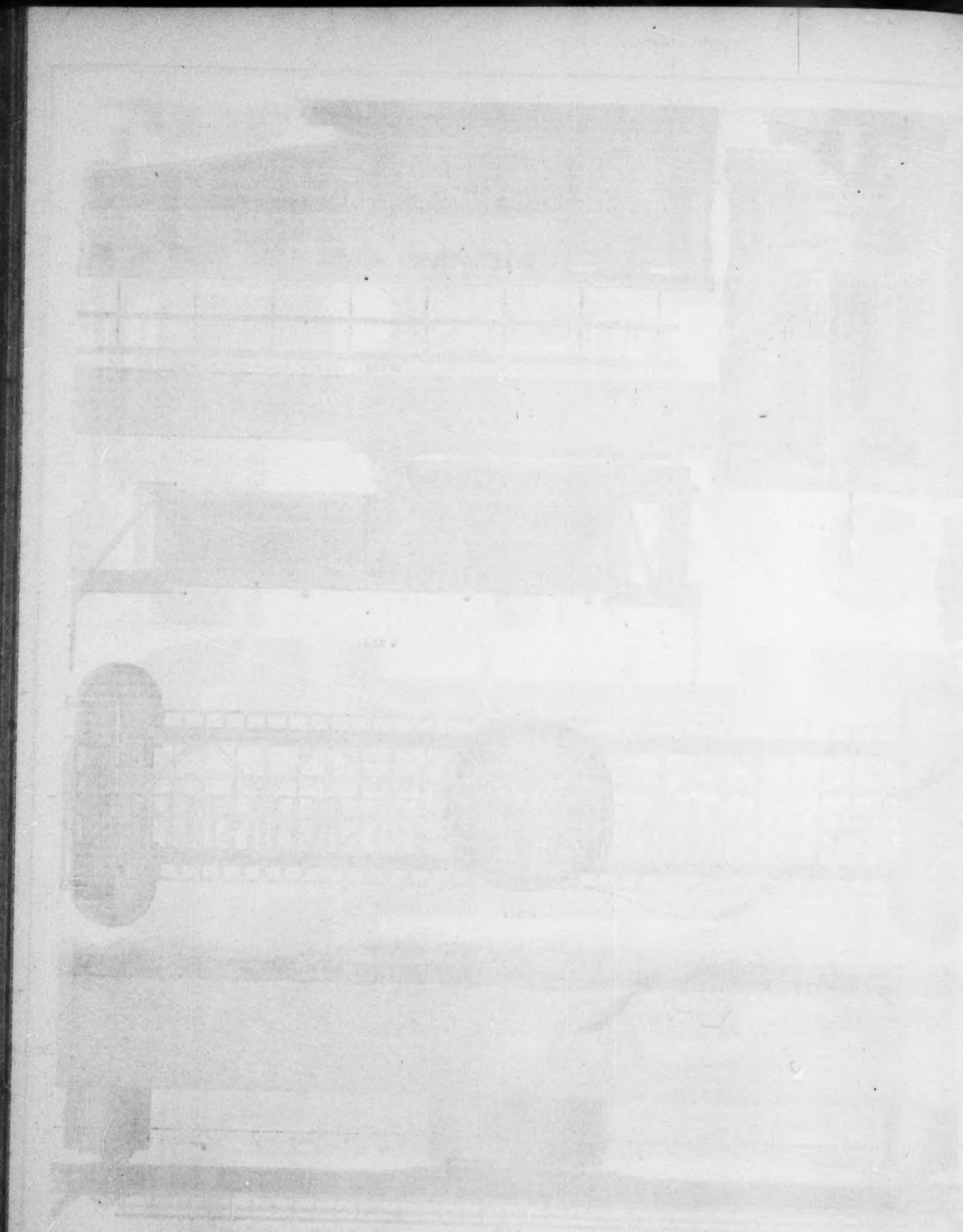
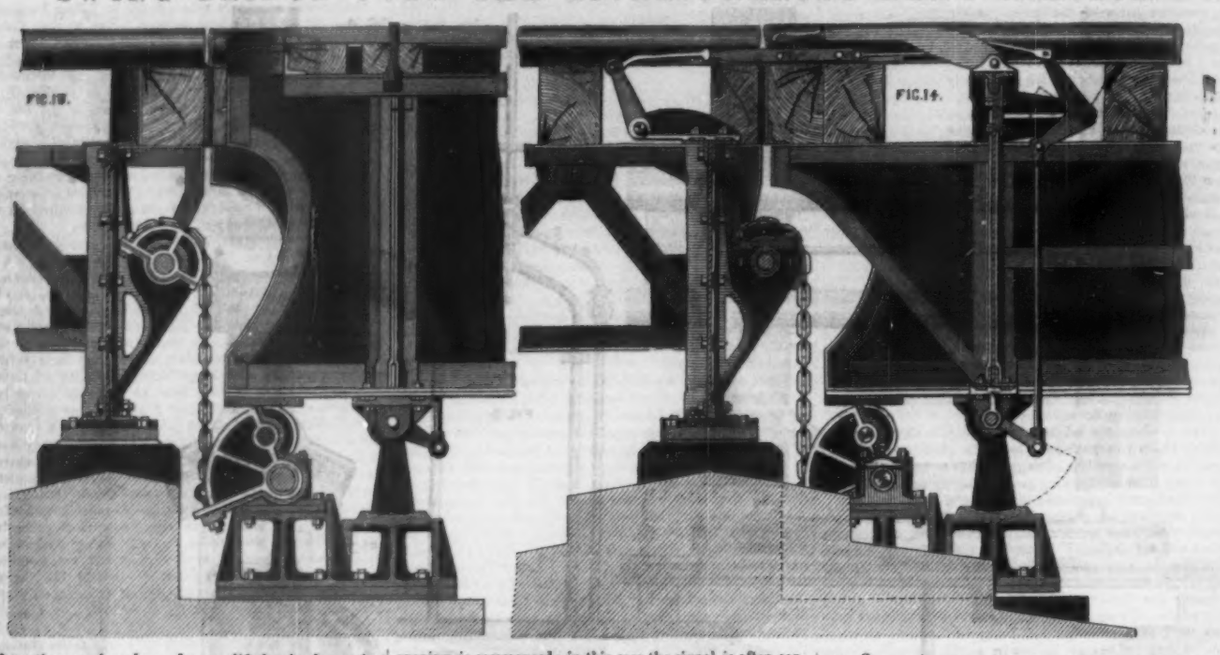
The lifting apparatus, shown above, is constructed according to this theory. An eccentric or cam with a friction roller is placed under the end of each girder; this eccentric must be fitted in its bearings in such a manner that it occupies a horizontal position at the commencement of the lifting operation. The eccentric receives its motion from a quadrant of 10 in. diameter, over which passes a chain, the length of which can be regulated by means of a nut and screw attached to one end of the latter; the other end is fastened to a semi-circular chain wheel of 5 in. diameter. The chain wheels of the apparatus, under the ends of the girders, are fastened to a common shaft, 29 ft. long, which carries at its ends the counterweights, whilst one end is besides provided with a spur wheel, that can be moved backwards and forwards by means of a pinion. The counterweight consists of discs, the number of which may be increased or diminished for the better regulation of the apparatus. The eccentric or cam is 6 in. radius, that is, is 1 in. more than the total lifting of the end of the bridge; the eccentric will thus pass through a length and a quarter of a circle in producing a lift of 5 in., but the excess allows for rectifying any mistake in the calculation of the deflection. But the eccentric is not used as a support for the bridge when under traffic, and for each girder there is, therefore, added a special movable bearing, which has to be applied after the bridge is lifted, in order to support the structure properly. These two supports are fixed upon a common shaft, the rotatory motion of which, by means of bell cranks, is made dependent upon the movement of the shutting and signalling apparatus. This latter arrangement is shown in Fig. 14. The two timber beams, which are placed close together, and one of which belongs to the fixed and the other to the movable part of the bridge, carry brackets, through which a fastening bar is passed, but



SWING BRIDGE OVER THE RIVER PARNITZ NEAR STETTIN.



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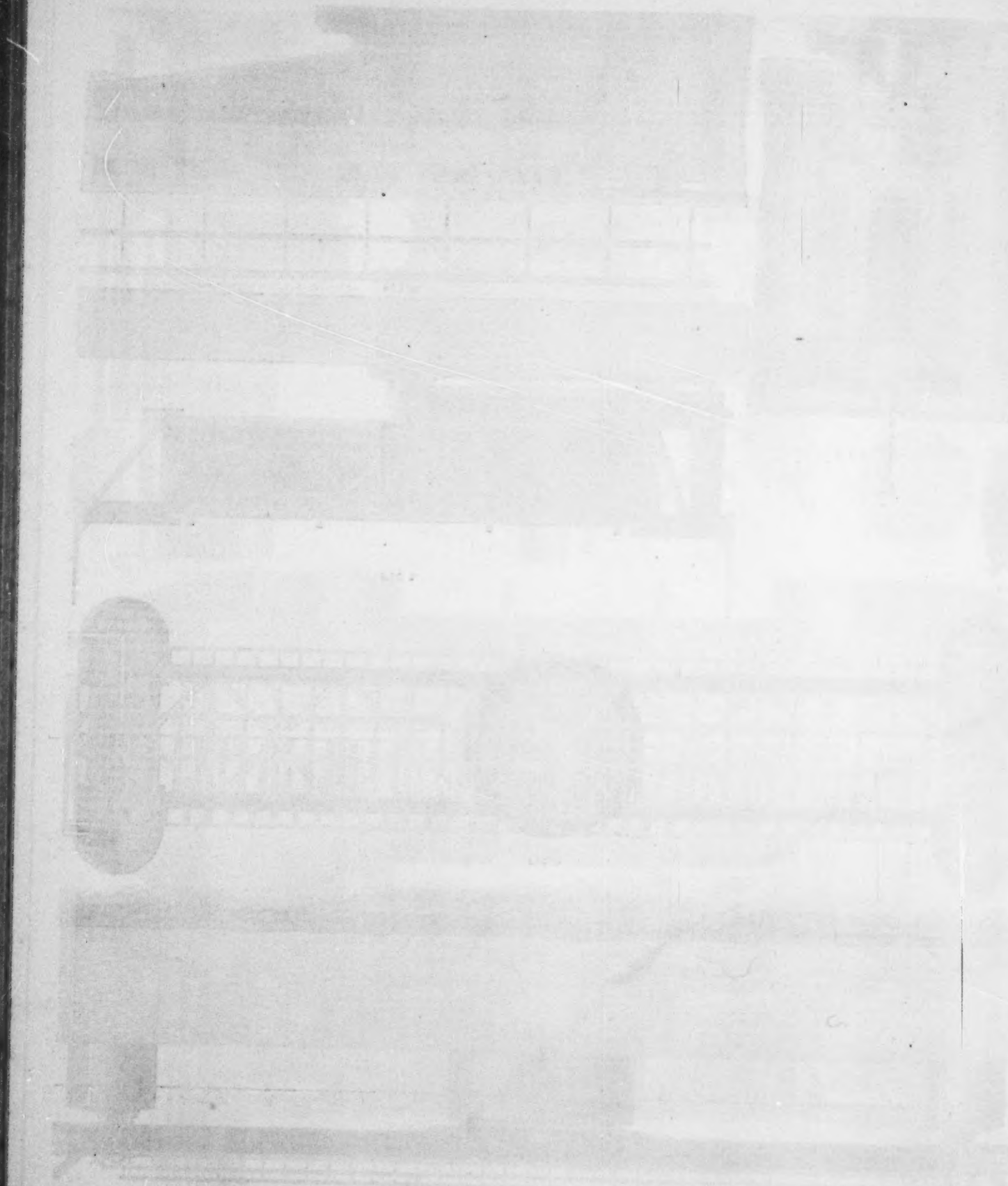


SWING BRIDGE OVER THE RIVER PARNITZ NEAR

(For Description see Page

FIG. 1.

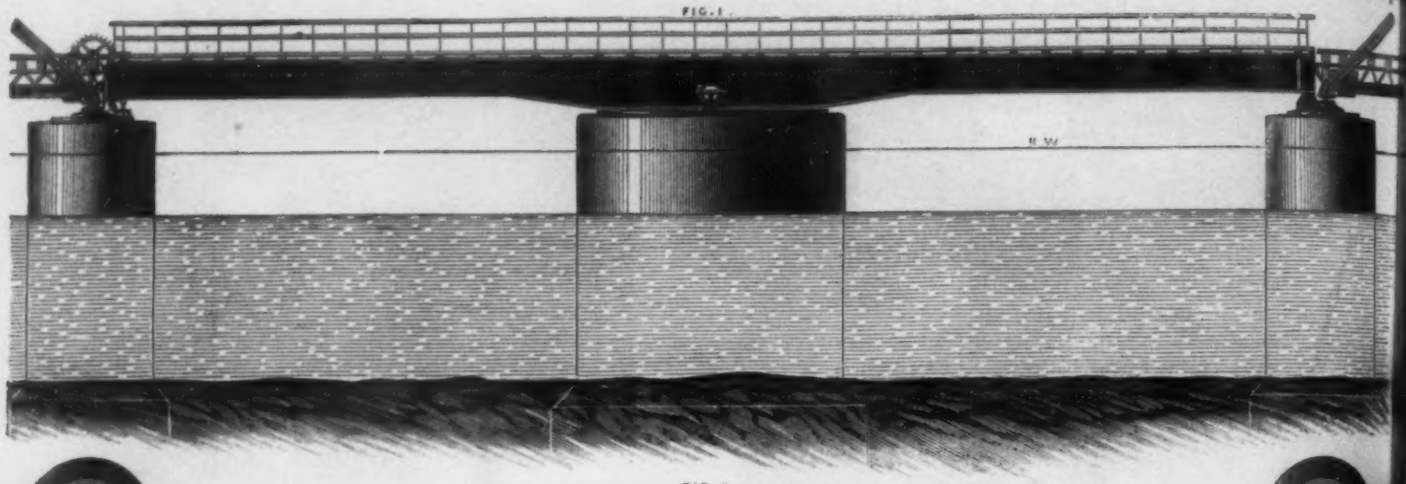


FIG. 2.

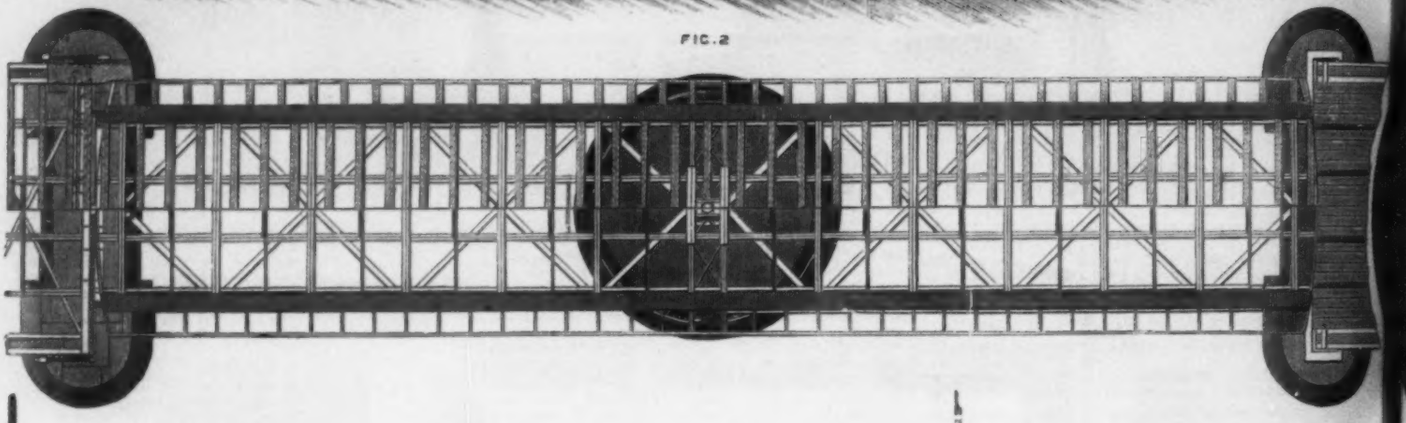


FIG 9.

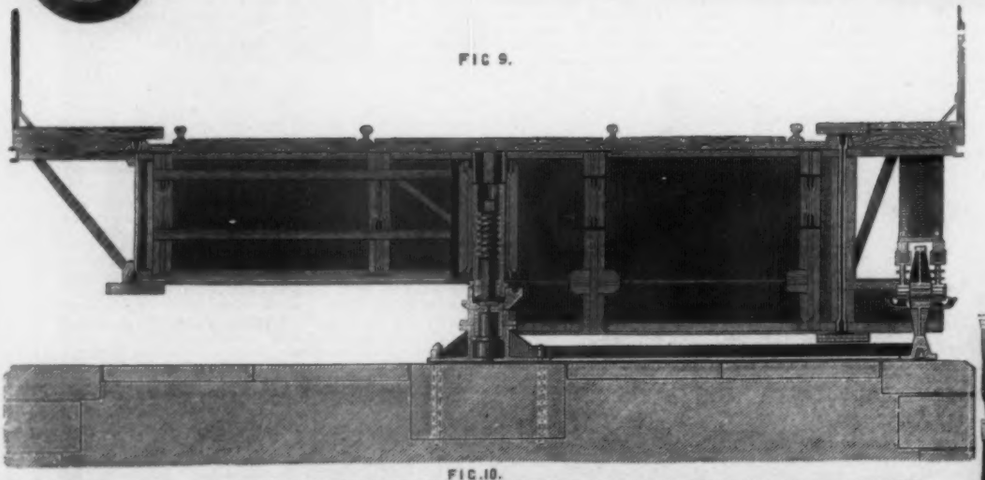


FIG. 8.

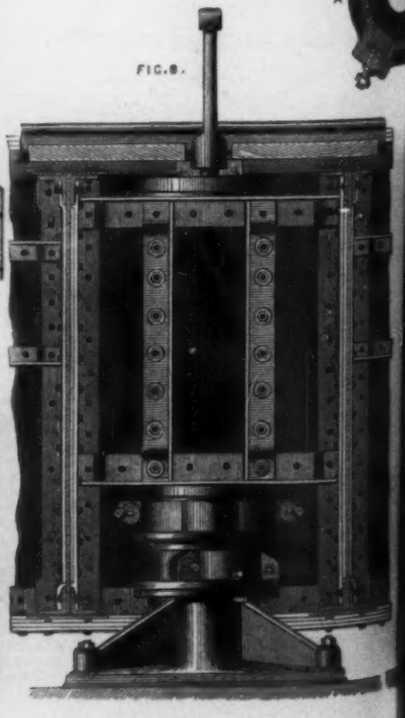
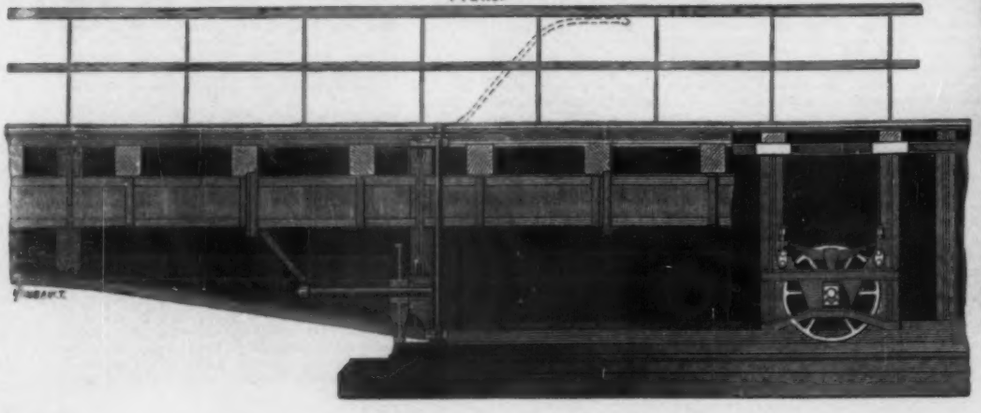


FIG. 10.



AR STETTIN; BERLIN AND STETTIN RAILWAY.

(See Page 154.)

FIG. 3.

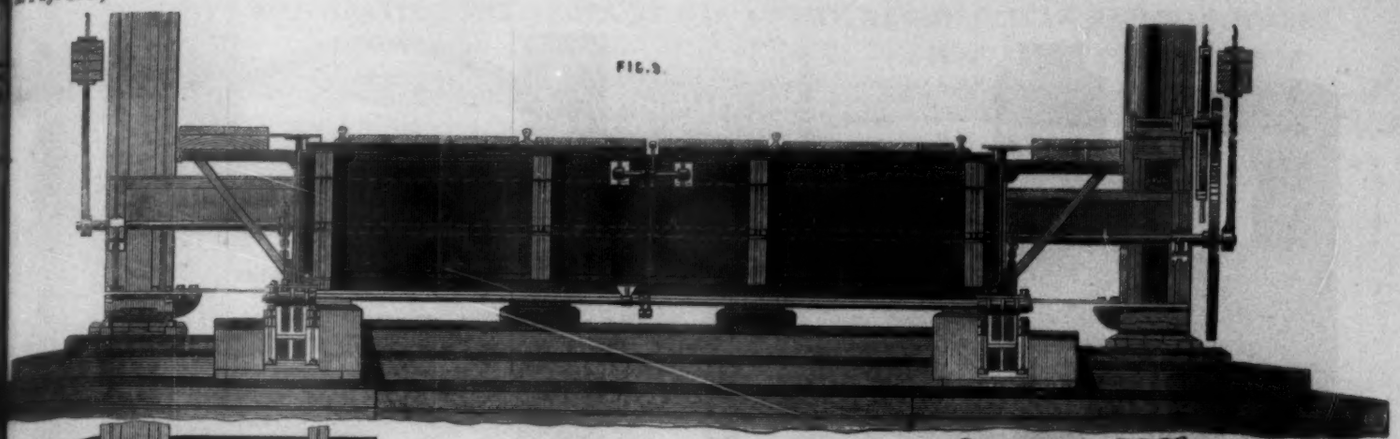


FIG. 4.

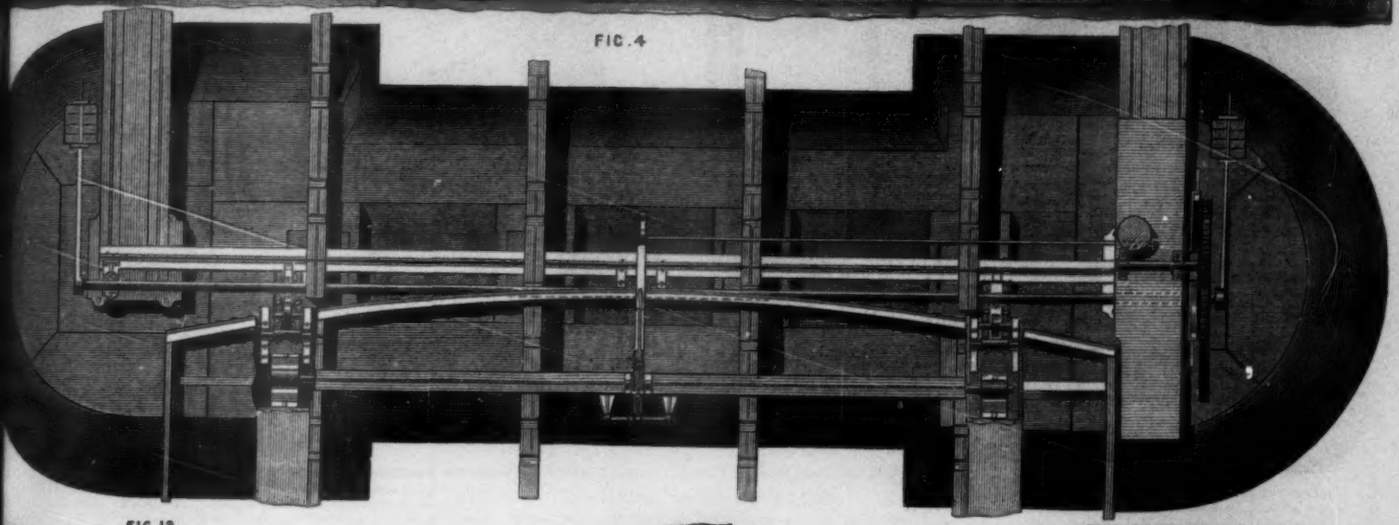


FIG. 12.

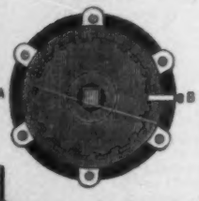


FIG. 1.

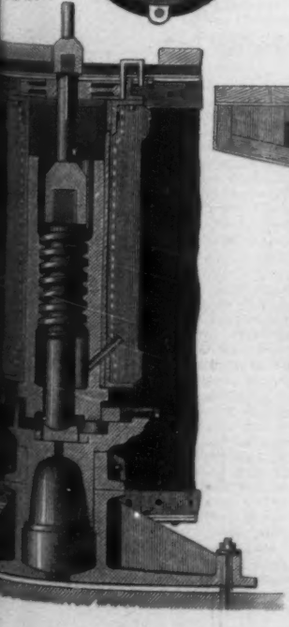


FIG. 6.

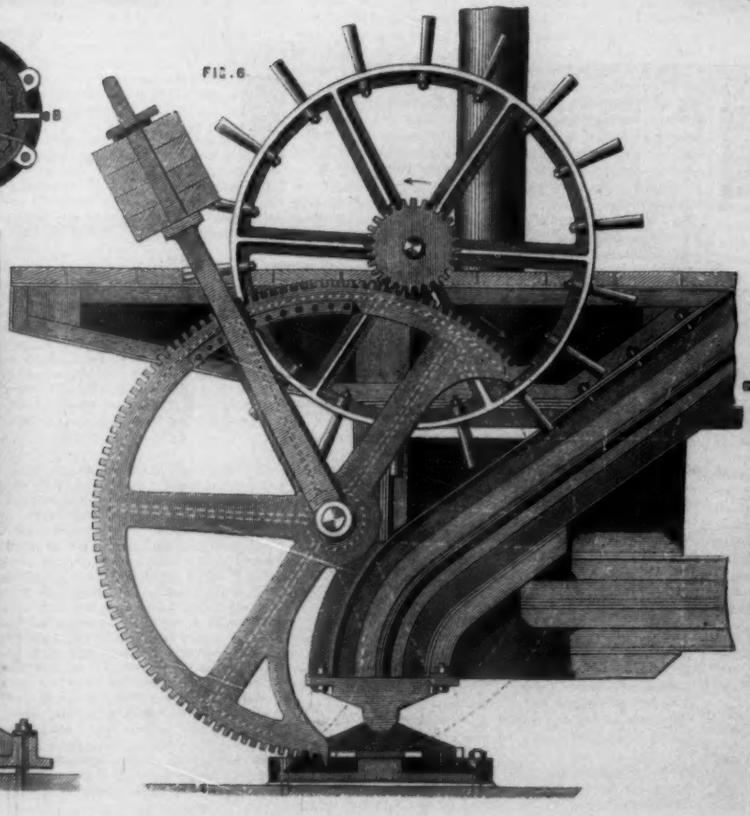
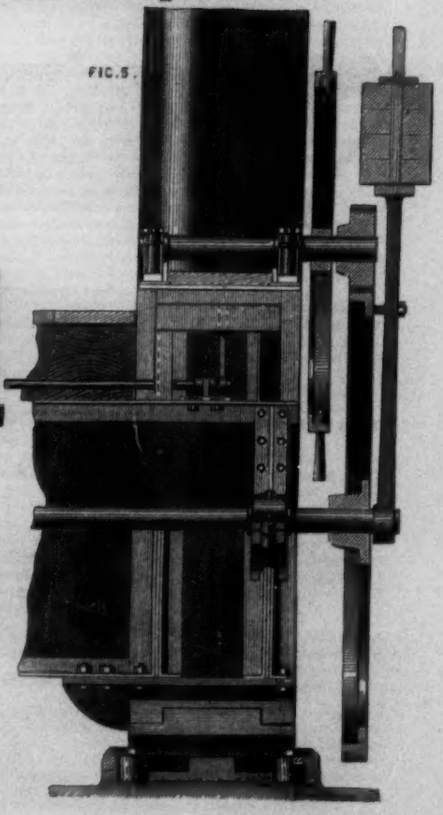
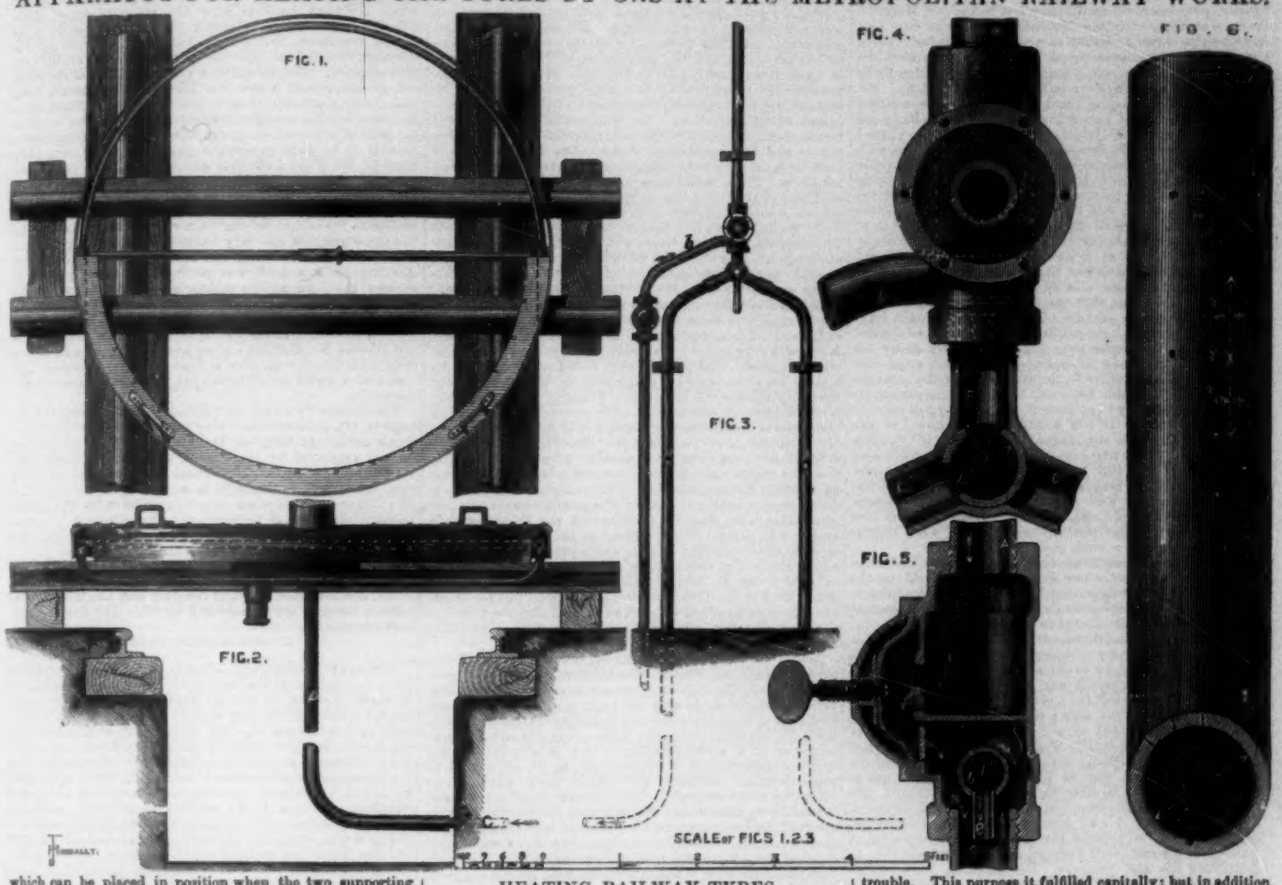


FIG. 5.



APPARATUS FOR HEATING THE TYRES BY GAS AT THE METROPOLITAN RAILWAY WORKS.



which can be placed in position when the two supporting arms or sockets are brought simultaneously into their correct place. The fastening bar pushes at the same time the sliding rod from the bracket in the fixed part of the bridge. The sliding rod is connected by means of the hand lever with the shaft beneath the end of the girder, and regulates in this manner the signal for the opening of the bridge. This arrangement reduces the time and power necessary for raising and lowering the bridge to a minimum. A few words have finally to be said about the bearing plates at the other end of the movable part of the bridge. These bearing plates are firmly fixed in their horizontal position, whilst their height or vertical position is made adjustable. The outside bearing is provided with a socket, against which the girders of the bridge strike when the latter are turned into their place. A latch bolt prevents any backward movement of the bridge afterwards. This latch bolt has to be lifted from the middle of the bridge by means of levers. The arrangement is shown in Figs. 7, 8, and 9.

THE RAILWAY ACCIDENT AT SECLIN.—It appears from the brief details given in the Paris papers that the fatal railway collision on Sunday last was caused by the express train from the capital running into a mixed train which was being shunted. The violence of the shock caused the outer casing of the engine attached to the express train to be broken, the consequence of which was the immediate pouring forth of volumes of scalding steam. Four passengers died in consequence of the injuries thus caused, and 71 others were more or less hurt.

STEAM PUMPS IN COLLIERIES.—Messrs. Hayward Tyler and Company, of Upper Whitecross-street, have lately put down another large direct-acting steam pump for raising water from a colliery. This pump, which has just been set to work in the upper main seam of Mr. Richard Forster's Trimdon Grange Colliery, at Ferry Hill, Durham, is of the same general construction as that at the Broad Oak Colliery illustrated by us on page 46 of our last volume, but is larger than the latter, while an improvement has been made by fixing the steam cylinder and the two pump cylinders on one bed-plate. The steam cylinder is 40 in. in diameter with 4 ft. stroke and there are two pumps each with a 10 in. plunger worked, direct from the steam piston as in the pumping engine just referred to. The steam pump at the Trimdon Grange delivers the water against a vertical head of 360 ft. and through a horizontal distance of 180 ft., the steam for working it being supplied from a boiler on the surface by a pipe led down the upcut shaft. The pressure of steam in the boiler is 22 lb. per square inch. At present the pump is being worked at seven strokes per minute at which speed it raised all the water to be dealt with; but it is constructed for working at fifteen double strokes per minute if required.

HEATING RAILWAY TYRES.

For some little time past there has been in use at the works of the Metropolitan Railway Company, at Edgware-road, an apparatus for heating railway tyres by means of jets of mixed gas and air, which, from its convenience, deserves to be generally known. This arrangement, which is shown by the annexed engravings, consists of a ring of 1 in. wrought-iron gas tubing, provided with a cross pipe having on it a nozzle, to which a length of india-rubber tubing can be attached, as shown at D, in Fig. 2. The ring just mentioned has an internal diameter 1½ in. greater than the external diameter of the tyre to be heated, and the latter can thus be placed within the ring, being supported on a couple of rails, as shown in Figs. 1 and 2. The ring itself rests upon feet, which bear upon the rails just mentioned, and it is thus supported so that its centre line is opposite the centre of the width of the tyre to be heated. Loss of heat when the apparatus is in use is prevented by an annular sheet-iron casing, 4 in. wide and 5 in deep, which rests on the tyre, as shown, the heads of a series of rivets in the top of this casing bearing on the tyre, and leaving sufficient space between the latter and the cover for ventilation. The gas ring is pierced along its inner circumference with three rows of holes, about $\frac{1}{16}$ in. in diameter, arranged, as shown, two-thirds full size, in Fig. 6, the holes in each row being placed at 1½ in. pitch longitudinally.

The manner in which the gas and air are mixed before being supplied to the ring, is shown by Fig. 3, and by the enlarged detail views, Figs. 4 and 5. The 1½ in. gas pipe, A, through which the supply of gas is obtained, terminates in the gas valve, shown in section in Fig. 5, this valve having a chamber into which the air pipe, *b*, is led. This air pipe, which is 1 in. in diameter, conducts a supply of air from the blast mains in communication with the fan, and it is provided within the chamber of the gas valve with a short nozzle, *c* (see Fig. 5), which directs the current of air downwards into the exit branch, C. This exit pipe is furnished with a three-way cock, as shown in Fig. 4, by means of which the supply of gas and air can be directed into either of the branches C′ and C″, by which it is conducted to the heating rings. The arrangement of mixing pipes, shown in Fig. 3, is situated against the wall of the shop, so that it is quite out of the way, while the heating rings are, when in use, placed at those parts of the shop which are most convenient. When not in use, the rings can be readily detached from the india-rubber pipes, D, and placed on one side.

The apparatus we have described was originally devised for the purpose of softening steel engine tyres, which had become too hard to be turned up without considerable trouble. This purpose it fulfilled capitally; but in addition to this it is now used for expanding engine tyres when they have to be removed from, or placed upon, the wheels, and it is found to be a most efficient and convenient arrangement. In using it the gas is first turned on and lighted, and the supply of air is subsequently added gradually until, by the appearance of the flame, it is seen that the proportion which gives the most intense combustion has been reached. At present, the gas apparatus is employed at the Metropolitan Railway Works for heating the large engine tyres only, the carriage tyres—which are more readily handled, and which generally have to be dealt with a number at a time—being heated in a circular fire. The time occupied in heating one of the engine tyres by gas, to an extent sufficient for placing on a wheel, is about 20 minutes; but the time is a secondary consideration compared with the general handiness of the apparatus, and the fact that it is always at once ready for use when wanted. The apparatus also possesses the advantage of rendering the overheating of a steel tyre impossible.

We may mention here that some ten years or so ago, an apparatus for heating tyres by a mixed gas and air flame was tried at the Great Eastern Railway Works, at Stratford, by Mr. Harrison, the foreman of the boiler shop there. This apparatus, however, differed from that in use at the Metropolitan Railway Works, in the fact that instead of a supply of air being drawn from the blast main, the mixture of air and gas was effected close to the point of ignition, as in the ordinary Bunsen burner.

In workshops where but a moderate number of tyres have to be dealt with, such an apparatus as that of which we give engravings, will prove exceedingly useful, while we believe that there are many other heating purposes for which the mixed gas and air flame might be advantageously employed. In conclusion, we should state that we are indebted to Mr. Robert H. Burnett, the locomotive superintendent of the Metropolitan Railway, for supplying us at our request with a tracing of the apparatus we have illustrated.

EUROPEAN AND NORTH AMERICAN RAILWAY.—This line between St. John and Bangor is rapidly approaching completion. At the last dates there were only 9 miles of track to lay, and the necessary rails and sleepers were on the ground.

TORPEDOES.—Messrs. Spencelayh and Archer, engineers of Chatham, have now a large number of men engaged in completing the cases for torpedoes ordered by the War Department, the last order being for 500 cases smaller than the many previously made, these small cases being intended to receive a charge of only 1 cwt. of gun-cotton. These iron cases are tinned on the outside to preserve the metal.

THE STOWMARKET EXPLOSION.

THE proceedings in this protracted and exhaustive investigation were resumed on Monday last before Mr. Marriott, the local coroner. Captain Majendie, R.A., who was sent down by the Home Secretary to assist in the investigation, and Professor Abel were again present, as were also Mr. Keates and Dr. Dupre, analytical chemists, from the Privy Council Office and the Metropolitan Board of Works. Mr. Eustace Prentice was questioned on certain points relating to the manufacture of gun-cotton and to the works by the coroner and Captain Majendie. In his replies he explained that what he meant by free acid was acid uncombined with alkali or any other substance. He was firmly of opinion that even if the cotton in the magazine had ignited—being pure gun-cotton, we presume—it might have inflamed the magazine, but would not have caused an explosion. Some two years since some of the company's cotton ignited at Penrhyn, when it simply inflamed but did not explode. Gun-cotton inflamed at a less heat than 340 deg. He did not think the explosion had been caused by inflaming but by detonation. If one disc of gun-cotton only were exploded by a detonator, that one disc would cause the whole of the gun-cotton to explode. He did not believe a detonator could possibly have got into the magazine, as the few there were at the works were kept very strictly under his own charge. He knew of nothing that would cause the impurity or decomposition in the cotton except the presence of free acid. It would, however, have been impossible for such a large quantity to get into it, as shown by the samples from Upnor, unless it was wilfully placed there, or got there through gross negligence. The object of putting chalk into the cotton was to prevent the presence of free acid by absorption. He still held that if an atom of impure cotton got into the magazine it would cause an explosion. He believed that the acid discovered in the Upnor cotton was designedly placed there, the acid having been put into the tanks outside the poacher-house, which were unprotected, thus forming a weak point in the works.

Captain Majendie observed, that the supposition that some person had deliberately and wilfully put the acid in the cotton was so very serious, that he must ask Mr. Prentice to repeat his reasons for his conclusions upon that point, and also to state if he still adhered to his belief.

Mr. Prentice stated that he still adhered to that conclusion, and his reasons for so doing were, firstly, that the gun-cotton samples sent back to them from Upnor Castle were in such a state that it could not possibly have passed their test; secondly, they had the fact that the acid was distributed unequally through the mass; thirdly, that no cotton that had been washed could have contained such a quantity of acid; fourthly, the quantity of chalk with it showed that it had been passed by them. He considered that the quantity of acid discovered in that at Upnor was even in excess of that which would be in after the cotton was first rinsed. No free acid had been discovered in the rinsing cotton, he therefore assumed that it had been put into the Government cotton in order to prevent the Government contract from passing or for some such purpose, and not with the view of destroying life and property. He, however, knew of no circumstance that could lead any person so to injure either the Government or the company.

Mr. James Baxter, clerk to the Gun-cotton Company, gave evidence touching the quantity of gun-cotton sent away, the times of deliveries, the quantities in store at the time of the explosion, the registering of the tests, and various other similar matters, which were for the most part simply confirmatory of evidence previously given by Mr. Trotman, Mr. Slater, and Mr. Prentice.

Professor Abel was the next witness, and to a considerable extent his evidence was naturally only a repetition of much that had been previously given. He first referred to the testing of samples of both Government and mining gun-cotton taken from the works after the explosion, and also of samples from Upnor. The former he stated were all found perfect, whilst of the Upnor samples some were very acid. They differed in their degrees of acidity, some having undergone partial decomposition, whilst others were only slightly acid. Some of the samples were exposed to the open air in a room, and when subsequently examined were found to have lost their acidity. Of the discs in the boxes at Upnor only a small proportion in each box—sometimes not more than three—was found to be strongly acidified. The examination showed that there was only a small proportion of really bad gun-cotton distributed through a large proportion of good material. He could not account for the presence of the sulphuric acid, and, from his knowledge of the process of manufacture at Stowmarket, he was convinced that it was quite impossible for gun-cotton as he found it to have passed through the whole of the processes, and to have been left untouched. The acid must have found its way into the cotton, either by accident or design, after the conclusion of the purifying operations. Cotton in the condition of the bad samples would be liable to rapid decomposition, the result of which would probably be ignition, and if that took place in a confined space the result would approach an explosion. The only conclusion to which he was led, was that the explosion was the result of the ignition of some very impure gun-cotton promoted and accelerated by the heat of the weather. Referring to the circumstance of a mass of smoke having been noticed by some of the witnesses, Professor Abel observed that practically there would be no smoke from pure gun-cotton if ignited. If, however a large quantity was ignited there would be a slight smoke caused by steam and nitrous vapours, and if the explosion were violent and destructive, it would carry with it dust and finely divided matter which would exactly resemble smoke. The stability of gun-cotton was quite possible in the earlier days of its manufacture at Stowmarket with careful manipulation, but the new process rendered stability much more certain. There were at Woolwich numerous samples of gun-cotton six or seven years old made by the early process, and which remained unchanged. Imperfect purification was one cause of instability in gun-cotton, but this had been quite overcome by the new method of manufacture. He thought the present site at Stowmarket was not a proper one for the storing of gun-cotton. As regarded the works he did not think that further precautions were necessary for their protection. He had not heard that gun-cotton could not be exploded except by detonation, and he had not authorised the publication of certain circulars, in which this was stated to be the case. In the open air, however, it was not possible to explode gun-cotton except by detonation; the degree of confinement would determine the extent of the explosion. The gun-cotton ordered by the Government from Stowmarket was intended for use in torpedoes and for engineering works. The torpedoes would have been carried in the holds of ships to various points and left there. There would have been no great danger of an explosion of slightly defective gun-cotton in the tropics, because it would never have been passed. Samples of imperfectly washed cotton had been stored in magazines at Woolwich exposed to the sun since 1866, and still remained there unchanged. The Professor thought that every effort should be made to assure the public mind by further experiments before gun-cotton was stored in large quantities anywhere.

At this stage the proceedings were adjourned to the following day. Upon their resumption, Professor Abel was recalled and further examined. The substance of his evidence, which was very lengthy, was simply a repetition in different phraseology and with a little more detail of that given by him on the preceding day, and which we have summarised above. Evidence was then taken touching the death of Mr. Edward Prentice, and also as to the working of the telegraph instruments in transmitting the results of the tests. Following upon this came the evidence of Dr. Odling, F.R.S., who testified to having examined samples of gun-cotton taken from the works, some of which were devoid of acid reaction and were in fact sound, whilst other samples were in a very decomposed condition. He had also tested some unfinished gun-cotton taken from the works which was found not to be acid to test paper. The remainder of Dr. Odling's evidence referred to the conditions under which explosion would occur and to the perfect safety of the Abel process of manufacture as carried out at Stowmarket. He thought the acid had been added to the discs before they were placed on the driers. Mr. Trotman was then recalled and stated that the names of the two girls missing had been discovered, and that they never went to the magazines.

Mr. T. W. Keates, the consulting chemist to the Metropolitan Board of Works, was next examined and gave evidence as to the stability of certain samples of gun-cotton taken from the works after the explosion, and the unsound condition of some other samples from Upnor Castle. At this point the examination of Mr. Keates was suspended in consequence of a communication which was made by Mr. Coulson, a gunmaker of Stowmarket, to the effect that he could produce witnesses who would solve the mystery attaching to the explosion. Mr. Coulson stated that a man named George Smith had told him that the men at the works received their wages on Friday evenings and came beery to their work on Saturday mornings; that they then worked carelessly and hurriedly, putting more cotton into the centrifugal machine than it would hold, that the machine got out of order and that the men threw acid from one place into another. On cross-examination by Mr. Poland on behalf of the Gun-cotton Company, Mr. Coulson declined to say whether he had brought Mr. Merriman down. He knew Mr. Merriman and also Mr. France who was interested in lithofracture. Mr. Merriman objected to the questions put by Mr. Poland and Mr. France to his name being introduced by counsel, whereupon Mr. Poland remarked that Mr. Merriman had been brought down by a rival manufacturer, that an attempt had been made to concoct evidence and he was entitled to show how this had been done. Then ensued a scene in the court, Mr. Merriman declaring that Mr. Poland was endeavouring to back up a Government monopoly out of which Mr. Abel was getting three or four thousand a year, and Mr. Poland complaining that Mr. France was directing offensive epithets to him across the table.

The man Smith was then sent for, and he stated that he had seen double the proper quantity of cotton put into the centrifugal machine that ought to have been, and he had seen boys cop cotton from one tank to another without washing it. Cotton had also been put into the tanks without having been in the centrifugal machine at all. He was formerly employed at the works as a blacksmith; had not seen the works for a fortnight before the explosion. At this stage the inquiry was adjourned for the night.

Upon their resumption on Wednesday, Mr. Merriman stated that Mr. France, a large quarry proprietor, who had used gun-cotton for quarrying purposes, could give testimony which would upset many theories respecting that substance. He, however, did not call Mr. France as a witness, although the coroner gave him the opportunity of so doing. Mr. Keates was then recalled, and gave in detail the results of his examination of the gun-cotton samples sent to him for that purpose. His evidence was in effect similar to that of previous scientific witnesses, with regard to the probable cause of the explosion. Dr. Dupre followed Mr. Keates, and inasmuch as he had conducted his examination of the gun-cotton samples in conjunction with that gentleman, his evidence in no way differed from that of Mr. Keates upon material points.

The available evidence having been exhausted Mr. Merriman said he took it to be the duty of both Captain Majendie and Mr. Lakeman (the factory inspector) to tender themselves as witnesses. Mr. Lakeman said he had no evidence to offer which would throw any light upon the object of the inquiry. Captain Majendie made a similar statement, adding that he hoped he knew his duty without any hints or suggestions from Mr. Merriman.

Mr. Merriman then addressed the jury observing that the explosion at the works had been followed by an explosion of theories about the safety of gun-cotton. After a gross attack upon Professor Abel—than whom he said he had never met a more infatuated man in the whole range of his scientific experience—and upon scientific men generally as regarded evidence, he proceeded to attack the arrangement and management of the Stowmarket works and the experiments which had been made to prove the safety of sound gun-cotton. In conclusion he stated that Mr. France, a large quarry proprietor, had contributed to the expense of his advocacy on behalf of some poor people who had suffered by the explosion. Mr. Poland in reply complained of the loose and general attack which Mr. Merriman had made upon honourable gentlemen without reference to the actual facts. He admitted that changes in storage were desirable, but that the general safety of the works and process of manufacture as well as of pure gun-cotton had been fairly and fully proved. He pointed out that acid had got into the cotton after it had left the poachers, and that it must have been put there by design.

The coroner then summed up the evidence, directing attention to the salient points. After deliberating for an hour and three quarters, the jury returned the following verdict: That the explosion causing the deaths of persons on whom this inquest was held, was produced by some person or persons unknown adding sulphuric acid to the gun-cotton subsequent to its passing the tests required by Government; at the same time we consider from the evidence adduced that there is no danger in the manufacture of gun-cotton in the wet process, but that the drying and storing of gun-cotton should not be allowed near a town; also, we consider that gun-cotton works should be subject to constant Government inspection.

The coroner then said he considered that throughout the inquiry Mr. Merriman had very unwarrantably abused Professor Abel. At first, too, Mr. Merriman had denied that he was employed by Mr. France, but he now admitted it. He had also denied that Mr. France was connected with any rival manufacture, although it was a matter of fact that Mr. France was in some way connected with the Lithofracteur Company at Cologne, and that Captain Majendie had, at the request of the Secretary of State, inspected a site for the manufacture of lithofracteur.

Mr. Merriman observed that the coroner's remarks applying to him did not require a reply in that place.

The coroner then thanked the jury and the Government officials for their attendance and services, and the proceedings terminated.

SANITARY EXHIBITION.—The Social Science Association have determined, at the request of many persons interested in sanitary reform, to hold an exhibition of sanitary appliances at their forthcoming annual Congress, which is to be held at Leeds, from the 4th to the 11th of October next. Among the articles which it is intended to receive are filters, water fittings, taps, standpipes, and pumps, closet apparatus, models and plans of improved workmen's dwellings, public baths and washhouses, gymnasiums, cottage and temporary hospitals, illustrations of various disinfecting processes, hospital ambulances, illustration of farm drainage and irrigation works, specimens of preserved meats and other dietetic articles, improved cooking apparatus, warming and ventilating apparatus, &c. The exhibition is intended to bring under the notice of health officers and the many men interested and experienced in sanitary questions in various parts of the kingdom, who usually attend the Congress, the latest appliances of science, having for their object the improvement of the public health, and will probably form a useful as well as an attractive feature of the meeting. Every information may be obtained on application to Dr. Robinson, Honorary Secretary of the Health Department, Social Science Offices, Leeds.

MOORGATE-STREET STATION.—From Friday last, when the London, Chatham, and Dover Company first ran their trains into the Moorgate-street Station, that terminus, for the present, will serve for the traffic of six companies—the Metropolitan, the Metropolitan District, the Great Western, the Great Northern, the Midland, and the London, Chatham, and Dover Companies. The Chatham and Dover Company added 60 trains, in and out, to the day's work, which brings the number of trains using the station to a much higher figure than at any other station in London, the trains received and despatched at Moorgate-street being now above 1000 per day. Divided management in the conduct of such an extraordinary traffic would, as regards control of points and signals, inevitably prove fatal, and it is accordingly wisely left, by the companies interested, in the hands of Mr. Myles Fenton and his responsible assistants, who direct the whole of the trains entering and leaving the station. The new station of the London, Chatham, and Dover Company at Moorgate-street consists of a single line only, with a platform on each side. This is the same accommodation as is provided for the Midland and the Great Northern Companies. The booking-office accommodation provided by or for the Chatham Company is better than that shared by the other five companies, but that is not saying much. The attentions paid, and the services fairly due to passengers arriving at the station by cab or other carriage greatly need to be improved and increased. There is no station entrance in London more infested by disreputable characters than that at Moorgate-street, now a terminus used by comparatively "long-journey" travellers, in addition to the passengers by the Underground line, who have not usually much luggage. A better attendance of railway servants at the entrances to the booking offices would save money and avoid discomfort to travellers. The eastern extension of the London, Chatham, and Dover from Blackheath-hill to Nunhead would have been opened on Friday also, it was expected, but the opening has been deferred for a short time to enable the contractors to finish the works more completely. The eastern extension will give a communication between the south side of Greenwich and the Crystal Palace, Clapham Junction, Victoria Station, Ludgate, Moorgate-street, and nearly 40 other railway stations.

RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 2451, 6d.) Andrew Barclay, of Kilmarnock, patents arrangements for heating blast furnace charges before their admission to the furnace itself. According to these plans jets of air are forced into the furnace, by the aid of steam jets, at a point a short distance below the top, and flues are provided for conducting the products of the combustion thus set up, past the charging bell so that they may act upon the charge which happens to be resting on the latter. We do not see what advantage Mr. Barclay is likely to obtain from such an arrangement. The patent also includes making the charging bells of blast furnaces so that water may be caused to circulate through them.

(No. 2557, 1s. 6d.) John Tatem Rich, of 480, Library-street, Philadelphia, patents various arrangements for admitting air to boiler furnaces and stoves. We have not been able to discover any novelty in these plans unless, perchance, there may be anything new in the form of perforated "rosettes" which Mr. Rich applies at the inner ends of his air passages for the purpose of distributing the air, and the existence of which in most furnaces would, we fancy, be of very limited duration.

(No. 2559, 1s.) Philippe Kochs, of Manchester, patents a simple, but ingenious machine for tapping nuts which we intend to illustrate shortly, and which, therefore, we need not describe here.

(No. 2572, 10d.) John Russell Taber, of Fairhaven, U.S., patents, as the agent of Howard Perkins, of Mansfield, U.S., the arrangement of cord twisting machine illustrated by us on page 417 of our last volume.

(No. 2581, 10d.) Thomas Moore and Charles Arthur Head, of Stockton-on-Tees, patent an arrangement of pulley block in which the wheel over which the hand-chain passes has cast in one piece with it a pinion which gears into an internal wheel cast on the wheel over which the hoisting chain is led. The axes of the driving and hoisting wheels are formed in one piece, an intermediate cranked portion giving them their necessary relative positions. The arrangement is a very simple one.

(No. 2584, 1s. 6d.) John Hill and Alexander Morton Strathern, of Castbridge, patent arrangements of wood working machinery capable of sawing wood into planks, and at the same time grooving or rebating the separate planks so formed. The patent also includes arrangements of feed motions which we could scarcely explain clearly without the aid of drawings.

(No. 2586, 1s. 6d.) John Brunton, of Great George-street, and Richard Christopher Rapier, of Westminster-chambers, patent arrangements of locking gear, &c., for railway switches which we could not describe briefly, but of which we may probably have something to say on a future occasion.

(No. 2588, 10d.) Robert Elsdon, of Brockham, patents an extraordinary arrangement for coupling the wheels of locomotive engines and tenders. Mr. Elsdon divides the wheels into groups and couples the wheels of each group by means of coupling rods moving in guides and carrying transverse slides in which the crank pins work, while the several groups are coupled by other rods, each of which is made in two parts with a spring connexion so that the rod may elongate or contract as the bogies to which the groups of wheels belong pass round curves! This idea of employing spring coupling rods is new and startling; but it unfortunately happens to be open to the trifling objection that it, of course, would not work.

(No. 2590, 4d.) James Henderson, of New York, patents improvements in the mode of carrying out his process of purifying iron. According to these plans the powdered fluorides or fluor spar mixed with metallic oxides are mixed with water and charged into the moulds which are subsequently to receive the metal to be purified, the moulds being of course allowed to dry before the metal is run in.

(No. 2600, 8d.) Thomas Russell Crampton, of Great George-street, patents arrangements of furnaces worked with powdered fuel. The leading feature in these plans is that the materials to be melted or heated are placed at the bottom of the furnace and are heated by jets of air mixed with powdered fuel which are projected downwards on to them, the products of combustion returning upwards through the furnace.

(No. 2605, 8d.) William Brown, of Saint Mary-street, Portsmouth, patents a form of paddle wheel having the floats made each in two parts placed inclined to each other so as to form a series of V's round the periphery of the wheel. This is an old plan, and it is almost unnecessary to state that it is far from possessing the advantages which sanguine inventors have claimed for it.

THE LOUISVILLE CANAL.—A committee of the Cincinnati Chamber of Commerce recently made a report to that body on the progress of the enlargement of the Louisville and Portland Canal, having passed through that work in company with General Wetzel, U.S. Engineers, who is in charge of the improvements round the falls of the Ohio. The committee expresses an opinion that by October 20 boats 335 ft. long and 80 ft. wide will be able to pass through the locks and channels excavated through solid rock. The total probable cost of the work is set down at 1,263,200 dols. or 19,700 dols. more than the original estimate.

SHOEBURYNESS EXPERIMENTS.

A FEW parting shots were fired the other day at the old Millwall target, the "virgin shield," that resisted so effectually the combined attacks of the heavy guns that were trained against it in 1868. This shield, in common with many others that have resisted, according to their respective abilities, the attacks of heavy metal and much powder, and stand now pitted and battered relics of those numerous struggles, are, we believe, consigned to the scrap heap, and will soon be sold as old iron. For one reason, perhaps, the War Office will be glad to get rid of the Millwall shield: so long as that target stands at Shoeburyness, it remains a constant reproach to the authorities who rejected it in favour of more official but less effective devices. The target designed originally, very properly, with a view to economy, was not the most favourable example of the form it embodied, yet the results obtained from it were so remarkable that the Russian Government eagerly accepted the system, and is to-day adopting it universally. Perhaps some day we may follow in the same steps. Meantime we trust that if the target is removed, it will shortly be replaced by another on the same system, which Mr. Hughes is, we believe, now constructing, with the view of bringing it to England, and exposing it to the severest trials of our heaviest ordnance.

Five rounds of Palliser's projectiles from the 9-inch gun, at 50 yards range with battering charges, were fired on the old target the other day, the results being in all respects similar to the earlier attacks made in 1868. The shield remained effective, despite the heavy fire it had received collectively upon its small area.

Targets Nos. 34 and 35 were also fired at at Shoeburyness on a recent occasion. These targets, which we have already described and illustrated, are composed—the first, of a 14 in. solid plate, with 15 in. backing and a double ½ in. skin; the second of an 8 in. plate, backed by 9 in. of timber, at the rear of which comes a 6 in. plate, backed by 6 in. of timber, the whole being lined with two ½ in. plates. Against the former 6 rounds from the 11-inch gun were fired, the projectiles weighing 535 lb., and one round from the 12-inch gun, shot weighing 586 lb. Nine rounds were fired at No. 35 Target. Of these 6 rounds were from the 12-inch gun, throwing both shot and shell; two were from the 11-inch gun, and one from the 10-inch gun. The range for the most part was 200 yards, and the powder charges 85 lb. The result of this practice appeared to show a decided superiority of the solid 14-inch plate target over the compound one, the penetration in the former instance being much less than in the latter, moreover the solid plate being more difficult to pierce, maintained the target in a better condition. Sir John Brown and Messrs. Cammell are approaching more and more nearly to perfection in the manufacture of armour plates, but while so little is left to be desired in this respect, much has yet to be done with regard to the backing of the targets. It will be long before our War Office authorities produce a better backing than the one which now stands condemned to final destruction behind the Millwall shield.

FOREIGN AND COLONIAL NOTES.

Paris, Lyons, and Mediterranean Railway.—Although this great system came through the war pretty well as regards an absence of great injury to its way works and plant, still it appears on further examination that the amount of loss sustained was larger than the sum given last week. That sum only represented the loss sustained through the military decisions of the French authorities, who more than once broke down works when they had better have left them alone. The whole loss sustained by the action of the French authorities was 46,000*l.* but to this must be added 50,800*l.* for loss sustained through the proceedings of the Germans. The company's works in and near Paris were also injured during the communist insurrection; but upon the whole, we may repeat that the company emerged from the terrible conflict with less loss than might perhaps have been anticipated.

Argentine Telegraphy.—There are 1228 miles of telegraphic wire already at work in the Argentine Republic and 2630 miles more will be laid during the ensuing year, making a total of 3858 miles. Buenos Ayres is at present in electric communication with Cordova to the north, Rio Cuarto to the west, and Parana to the east. It will also shortly be in instantaneous connexion with Santiago del Estero, San Luis, and Corrientes.

Cape Breton Coal.—The coal trade in Cape Breton is improving, mines which had been closed for years have recently been sold and re-opened. A railway now being constructed is one cause of the gratifying change which has taken place. This railway is being rapidly pushed on, and should it be completed by November very large shipments of coal will take place.

The Anglo-Brazilian Railways.—A Bill authorising the purchase of the Anglo-Brazilian Railways has become law in Brazil. Under the provisions of this Bill the Minister of Agriculture has ordered immediate surveys and estimates for the prolongation of the Pernambuco and Bahia lines towards the Upper San Francisco river, for which object an appropriation has been voted.

The Grand Trunk at Montreal.—The Grand Trunk Company's wharf track is now laid to the Richelieu Company's shed. Its further extension will be proceeded with until the track is laid to the Quebec Gate barracks, and next year it will be continued to Hochelaga.

Railways in the Argentine Republic.—We are officially informed that there are now 531 miles of railway open for public traffic in the Argentine Republic, 424 miles in course of construction, 1954 miles surveyed or being surveyed, and 531 miles conceded to private companies. At the corresponding period of 1870, there were only 458 miles open for public traffic, 60 miles in course of construction, 400 miles under survey, and 210 miles contracted for. The surveys of a line from Cordova to Tucuman have been concluded.

Telegraphy in the Greek Archipelago.—An English telegraph company represented locally by Mr. Manzavino has been busily engaged in operations for uniting the whole of the islands of the Greek Archipelago with the mainland by electric wire. Mr. Binney of the same company left Syra recently for Cyprus and Rhodes to decide upon the most suitable spot for laying the submarine cables. The completion of the enterprise will prove advantageous throughout the Archipelago.

Chilian Steam Navigation.—Certain efforts of the agent of the Compania Chilena de Vapores to extend the company's line of steamers as far as Panama are stated to be meeting with success. The greater part of the shares reserved for Lima are stated to be already subscribed for.

Canadian Pacific Railway.—The Canadian Government has decided to proceed with the Canadian Pacific surveys during the winter. It was at first decided to close operations with the fall, but on the report of Mr. Sandford Fleming the plan has been altered. A winter survey in British North America must necessarily, one would think, be a very rough affair.

American Steam Navigation.—A movement is in progress for starting an American line of steamers between New York and Antwerp. It is even urged that the line could be conducted without a subsidy. Emigrants from Belgium have now either to go to Havre or Southampton for a shipping port which involves loss of time and much additional expense. It is thought also that a large proportion of the general European emigration to the United States might be diverted through Antwerp.

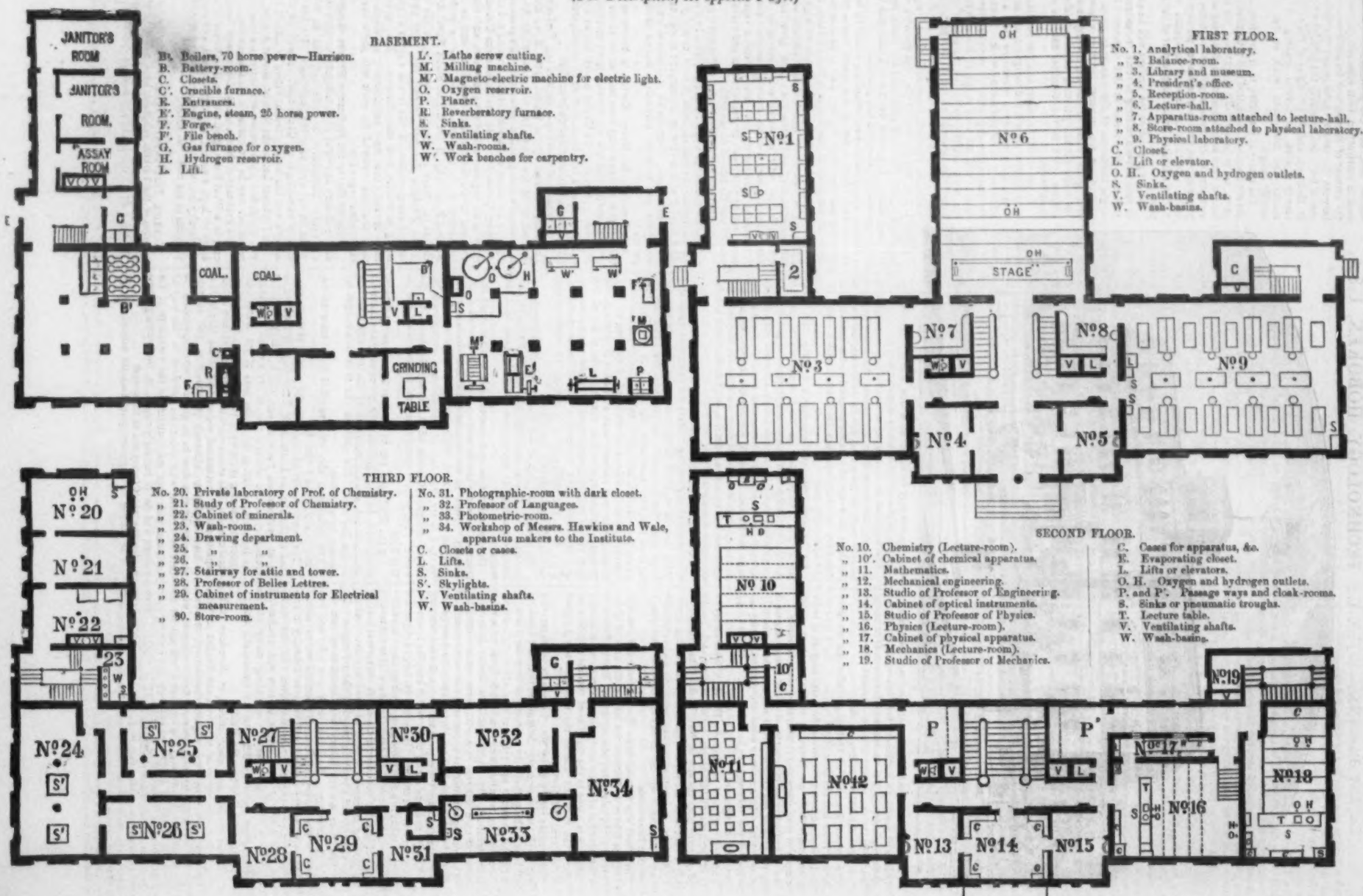
The Belgian Coal and Iron Trades.—The Belgian coal trade is in an active condition, upon the whole, although suffering from scarcity of rolling stock upon the railway lines. In the iron trade the rolling mills are not too well off for orders, but the various firms are looking out with energy for new contracts and are hopeful of success.

DRAINAGE OF HORNSEY.—In the late Session of Parliament an Act was passed for carrying out an arrangement made between the Metropolitan Board of Works and the Hornsey Local Board of Health, whereby the drainage of the district under the jurisdiction of the Local Board was allowed to pass into the northern high-level sewer of the Metropolitan Board, and find its way ultimately into the Thames at Barking Creek. The conditions on which the sewage of the district is to be permitted to pass into the metropolitan system of sewers are that the storm waters are to be separated as far as practicable from the sewage, and the discharge at the outfall not to exceed 500 cubic feet per minute. The Local Board are to construct the outfall sewer and all necessary connecting works, and to pay the Metropolitan Board the sum of 10,000*l.* in respect of the cost of the original construction of the main drainage works, and also to pay for the future by means of a rate on the same terms, and for the same time as the parishes within the metropolitan area; the amount annually required to meet the principal and interest of the main drainage debt, and further to pay annually their share of the cost of maintaining and working the main drainage system. The estimated cost of carrying out the scheme is 50,000*l.*, of which amount 10,000*l.* is to be paid to the Metropolitan Board, 10,000*l.*, the cost of the outfall sewer, 18,000*l.* for the internal drainage, and other items 12,000*l.* A tender for the execution of the works has been accepted by the Local Board, subject to the approval of the Secretary of State for the Home Department, pursuant to the provision of the Act of Parliament.

A GERMAN NAVAL INVENTION.—The *Bromberger Zeitung*, in a letter from Dantzic, gives some particulars regarding a curious and interesting addition to the German fleet. Three boats are just now in course of construction in Devrient's dockyard, the destination of which is to place torpedoes under, and thus to destroy an enemy's ships. These boats are built almost entirely of iron, and, being about 60 ft. long and only 6 or 7 ft. broad, they have nearly the form of a fish. The deck is not flat, but round, so as to be but little exposed to damage from an enemy's shot. While employed in active operations no one will be visible on board. Contrary to the usual system, these boats will be steered from the bows; and on the deck, above the rudder, there is a slight elevation to allow the steersman to stand on his feet, and a small opening about an inch wide to serve him as a look-out. As they are intended to operate close to an enemy's vessels the armour will be as thick as is consistent with high speed. The most curious part of the invention, perhaps, is that the tiny screw steamers, or barcassen (long boats), as they are called, use petroleum as fuel, which is contained in a number of iron receptacles in the stern, of sufficient thickness to be impervious to projectiles. The chimney is so small that it can scarcely in any case be hit. A narrow gallery, about a foot broad, and enclosed by an iron chain, runs round the boat. The machines have all been furnished by Stöckel and Wagenknecht, so that the boats have been produced in Dantzic from stem to stern. The hold for the torpedoes is in the middle of the boat, as well as the quarters of the crews. One of the barcassen has already been launched, and is only waiting for her engine. The two others are still on the stocks. A Liliputian steamer has also been constructed in the same dockyard, in which the inspector of the harbour works will be able to go on his rounds with great rapidity. The whole thing is not larger than an average-sized rowing boat; it has no deck, and in the middle is the miniature steam machine, which is no more than 2 ft. in diameter, and requires but little attention.

THE STEVENS INSTITUTE OF TECHNOLOGY, HOBOKEN, NEW JERSEY, U.S.A.

(For Description, see opposite Page.)



BASEMENT.

B. Boilers, 70 horse power—Harrison.
B'. Battery-room.
C. Closets.
C'. Crucible furnace.
E. Entrances.
E'. Engine, steam, 25 horse power.
F. Forge.
F'. File bench.
G. Gas furnace for oxygen.
H. Hydrogen reservoir.
L. Lift.
L'. Lathe screw cutting.
M. Milling machine.
M'. Magneto-electric machine for electric light.
O. Oxygen reservoir.
P. Planer.
R. Reverberatory furnace.
S. Sinks.
V. Ventilating shafts.
W. Wash-rooms.
W'. Work benches for carpentry.

FIRST FLOOR.

No. 1. Analytical laboratory.
„ 2. Balance-room.
„ 3. Library and museum.
„ 4. President's office.
„ 5. Reception-room.
„ 6. Lecture-hall.
„ 7. Apparatus-room attached to lecture-hall.
„ 8. Store-room attached to physical laboratory.
„ 9. Physical laboratory.
C. Closet.
L. Lift or elevator.
O. H. Oxygen and hydrogen outlets.
S. Sinks.
V. Ventilating shafts.
W. Wash-basins.

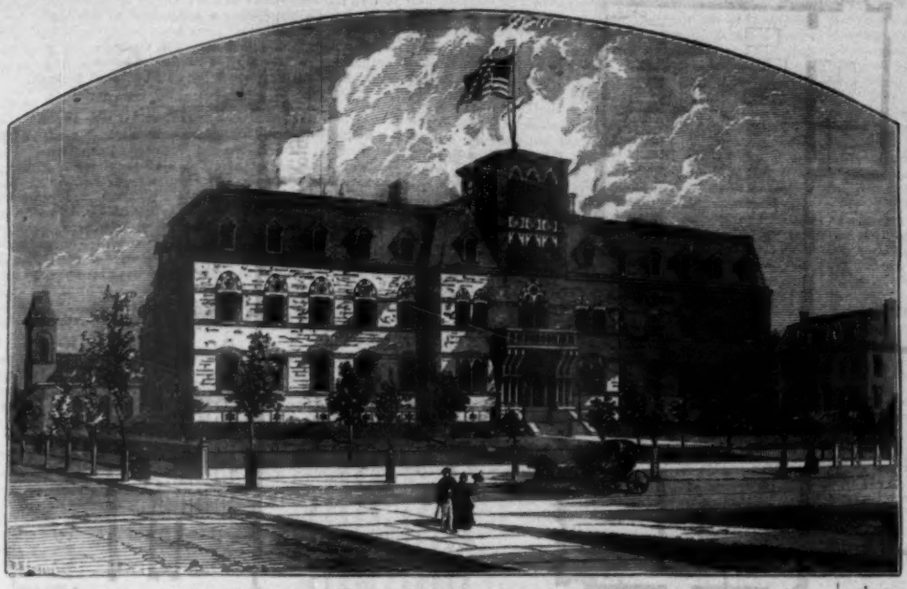
SECOND FLOOR.

No. 10. Chemistry (Lecture-room).
„ 10'. Cabinet of chemical apparatus.
„ 11. Mathematics.
„ 12. Mechanical engineering.
„ 13. Studio of Professor of Engineering.
„ 14. Cabinet of optical instruments.
„ 15. Studio of Professor of Physics.
„ 16. Physics (Lecture-room).
„ 17. Cabinet of physical apparatus.
„ 18. Mechanics (Lecture-room).
„ 19. Studio of Professor of Mechanics.
C. Cases for apparatus, &c.
E. Evaporating closet.
L. Lifts or elevators.
O. H. Oxygen and hydrogen outlets.
P. and P'. Passage ways and cloak-rooms.
S. Sinks or pneumatic troughs.
T. Lecture table.
V. Ventilating shafts.
W. Wash-basins.

THIRD FLOOR.

No. 20. Private laboratory of Prof. of Chemistry.
„ 21. Study of Professor of Chemistry.
„ 22. Cabinet of minerals.
„ 23. Wash-room.
„ 24. Drawing department.
„ 25. „ „
„ 26. „ „
„ 27. Stairway for attic and tower.
„ 28. Professor of Belles Lettres.
„ 29. Cabinet of instruments for Electrical measurement.
„ 30. Store-room.
„ 31. Photographic-room with dark closet.
„ 32. Professor of Languages.
„ 33. Photometric-room.
„ 34. Workshop of Messrs. Hawkins and Wale, apparatus makers to the Institute.
C. Closets or cases.
L. Lifts.
S. Sinks.
S'. Skylights.
V. Ventilating shafts.
W. Wash-basins.

THE STEVENS INSTITUTE OF TECHNOLOGY, HOBOKEN, U.S.A.



We have so frequently placed before our readers descriptions of American machinery and examples of transatlantic engineering, that we take especial pleasure in being able to offer, in our present issue, an account of a representative American School of Engineering.

The Stevens Institute of Technology, of which we give external views and the floor plans, is one of those institutions in which our cousins across the water propose to train the engineers who are hereafter to design their steam engines and machinery and to plan their manufactories.

An examination of the course of study offered together with the plan of the building itself will show how promptly and completely the American mind accepts and carries out the idea of the thorough technical education of the rising generation of engineers.

This institution is situated in Hoboken, New Jersey, a city of perhaps 20,000 people, which is separated by the Hudson river from the city of New York. The city forms really a suburb of New York, its inhabitants being generally engaged in business in that metropolis and communication being kept up by means of powerful and finely appointed ferry boats.

The school was founded under the provisions of the will of the late Edwin A. Stevens, the last of the sons of John L. Stevens, the celebrated competitor of Robert Fulton in the introduction of steam navigation in America. A brother of Edwin was noted as the designer of the ironclad Stevens Battery, the first and one of the most cleverly designed ironclads ever laid down.

The trustees appointed by Mr. Stevens to perform this great work, have evidently determined that the Institute shall lack nothing that may be required to make it one of the highest character as a school of mechanical engineering.

The building is an imposing structure designed by a well-known architect, Mr. Upjohn, of New York. It is constructed of hard blue trap rock, with brown stone trimmings. Our engravings exhibit its appearance and arrangement so well that we need not occupy much space in its description. In the basement are the engines and iron and wood-working machinery, and the steam boiler which supplies steam for heating and for the engines. Here, too, are large oxygen and hydrogen tanks in which those gases are kept under considerable pressure. From these tanks pipes are led to the several lecture-rooms. In the basement also are the several heating and melting furnaces required in the study and practice of metallurgy, and a powerful magneto-electric engine. On the first floor are the library and model-room and the physical laboratory. Each is a large room lofty and well lighted. The library will contain technical works almost exclusively, as the student will have no difficulty in procuring non-professional books elsewhere. In the model cases are some of the finest apparatus and mechanical models that can be procured, embracing many of the Redtenbacher series by Schrotter of Darmstadt, and by Schroder of Frankfort-on-the-Maine.

Ollivier models and many others of American make, illustrating peculiarities of American and English practice, are to be seen here. The physical laboratory, to which special attention has been given, is finely equipped with every description of apparatus required in the special investigations here pursued. In the rear and opening upon this floor is the large lecture-hall which is capable of seating 600 people. The stage is provided with water, gas, steam, and galvanic battery connexions, and shafting from which power may be taken by which to move an electro-magnetic engine or other heavy apparatus.

The whole of the west wing is devoted to the subject of chemistry, the lower floor containing the laboratory and balance-room, on the second floor is the lecture-room, and on the third floor are the rooms assigned to the professor of chemistry as study, private laboratory, and a room for special investigation.

On the second floor at the eastern end of the main building are the lecture-rooms of the professor of theoretic or rational mechanics and that of the professor of physics. In both these rooms the lecture tables are fitted with all the conveniences described as connected with the stage in the large lecture-hall, and each is well provided with apparatus. At the opposite end on this floor is a room for the use of the mathematical department fitted up with desks, black boards, and other accessories.

Adjacent to this room is the lecture-room of the professor of mechanical engineering. Here are the usual desks and black boards required in lecture-rooms. At one side are large cases for apparatus and models, the latter including some beautiful specimens, among which may be mentioned the beautiful model of Penn's oscillating engines with feathering paddle wheels which some of our readers may remember to have formerly seen at Elliott Brothers in the Strand. In this room will be found models of all of the well known and successful types of steam engine, marine and stationary, and locomotive and of other machines. Here is also a collection of specimens of material and models of the elements of machines.

On the opposite side of the room are drawers containing working and general drawings of various machines, and many engravings of appropriate character hang upon the walls.

On the same floor and immediately over the main entrance is a room which is used as a cabinet for optical apparatus. Here is the optical collection—including the celebrated "Bancker collection" of Philadelphia—collected by the late Mr. Bancker, of Philadelphia, pronounced by l'Abbé Moigno (Cosmos 1859, p. 55) the finest in the world. The private rooms of several professors are also on this floor.

On the third floor are to be found the drawing department, rooms for photographic work, photometry and electrical measurement, and the workshop of the instrument makers to the Institute. The room in the tower is arranged for acoustic experiments.

The building is also well supplied with store rooms, water closets, cloak rooms, &c.

The candidate for admission to the courses of study pursued at the Stevens Institute of Technology is required to be at least sixteen years of age, and to exhibit unusual proficiency in the ordinary preparatory studies. Entering the Institute, he during the earlier part of his course continues his training preparatory to entering upon the technical courses. He enters upon the technical studies of the department of mechanical engineering at the termination of his second year, although previously as well as subsequently to this date he is given every opportunity to become familiar with principles involved in the way of tools and with their manipulation in the workshops of the college, and he is regularly taught in the drawing rooms during the whole four years of the course.

The studies in engineering embrace the subjects of the nature, uses, and the presentation of materials used in construction, their strength and elasticity, the amount of friction and its effect when acting between the several substances; the forms and uses of tools, and especially the principles involved in their use, and the principles of the several accessory trades, as pattern making, moulding, smiths' and machinists' work, so far as they modify design.

The theory of machines, their structure, and the determination of the forms and proportion of their parts, are to be carefully taught, and the application of such knowledge to the designing and constructing of the more important machines, as the prime movers, are recognised as of primary importance. Lectures by experts on special subjects will to a limited extent form a part of the general plan.

At his graduation the student will be expected to read a thesis relating to some professional subject, and his success in this direction will be a strong indication of the manner in which he has profited by the unusual facilities offered him. During his course in the engineering department the student is also pursuing advanced laboratory courses, both in the chemical and the physical departments.

In the former he makes analyses qualitative and quantitative, organic and inorganic, and in metallurgy, and generally in directions that aid most effectively in his professional work. In the latter he makes investigations of physical laws, and enters upon the wide range of research in which his work contributes to the increase of physical knowledge as well as assists him professionally. His labours in the determination of physical constants, in accurate measurements of weight and volumes, and in the decision of the most probable value of his readings, are the more prominent and useful results of his work here. The usual courses in French and German and in general literature are also provided.

Finally, the authorities of the college evince an intention to make such effective use of the liberal means placed at their disposal that each student may, if he chooses, leave them at the close of his course a well-educated man of science and a good mechanic, so far as a knowledge of the principles of tool using and a limited amount of actual manipulation may make him one. They give him such a foundation of well arranged and thoroughly acquired knowledge and such a mental training as shall enable him to learn the practical part of his profession rapidly and easily and to profit well by the successes and the failures of himself and his fellows in the craft.

As brains, and not merely bricks and mortar, are necessary to the success of a school, and particularly a school of this character, the trustees seem to have carefully selected their faculty with a view to an energetic as well as a careful administration. They are all professional brethren, but who have yet to make themselves known to the world generally.

The President, Dr. Henry Morton, is known to us from the fact that he has a long time been editor of the *Journal of the Franklin Institute*, the representative mechanical and engineering journal of the United States, and as a physicist he has acquired a reputation both as an investigator and as a brilliant and successful experimentalist.

The professor of mechanical engineering, Professor R. H. Thurston, is stated by the United States *Army and Navy Journal*, to be the son of the oldest American mechanical engineer now living, and to have received his practical training with his father, and his theoretical training and education at Brown University. He has been in the United States navy as an engineer officer some ten years, and must have acquired invaluable practical experience, and he has also for several years been detailed to duty as professor of Natural Philosophy of the United States Naval Academy He has for years contributed occasionally to the columns of the *Franklin Institute Journal*, and other periodicals, lately having written for the former a series of papers relating to British iron manufactures. His opportunities have certainly been most exceptionally excellent, and we trust that the result of his work will prove that he has taken advantage of it.

Professor Mayer, the Professor of Physics, though young, also is already known as an investigator of high rank, and a frequent contributor to American, and an occasional writer for our own, scientific periodicals. He has enjoyed all the advantages of Continental as well as American schools, and has already taught fifteen or sixteen years.

To Professor Leeds, the chemist, almost similar remarks will apply, and great hopes are entertained that valuable researches may be prosecuted in his laboratories.

The Professor of Mathematics, Lieutenant-Colonel Hascall, is a West Point graduate and ex-officer of the U.S. army of high standing and attainments, and the other of the faculty are, we are assured, equally well fitted for their positions in the technical school.

TURKISH TELEGRAPHY.—Aghia Effendi, one of the inspectors of the Turkish telegraph lines, has been making a tour of inspection of the stations in Thessaly and Epirus. He found all the stations in fair working order.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—During the last week or so there has been a marked downward tendency in the price of pig iron warrants, but it is somewhat difficult to account for it. Of course there has been a considerable rise of late, and those parties who went in at the low figure must throw their iron on the market, and realise some time or other. This circumstance, together with the fact that there is some anxiety about foreign affairs in the present very sensitive state of the warrant market, may account for a temporary depression; but the general iron trade of the country remains in a very satisfactory condition. Pig iron makers' prices remain unchanged, and there is an increasing demand for all kinds of manufactured iron. Last Wednesday's prices for warrants were 62s. 3d. to 62s. one month, and 62s. 4d. to 61s. 9d. cash. On the following day there was practically no change, but on Friday business was done down at 61s. 3d. one month, and 61s. 1½d. cash. The market was very flat on Monday; prices fell, but they improved again in the afternoon. There was little change yesterday, and the market to-day has again been flat, and very little doing. 60s. 9d. cash taken, closing sellers; buyers at 61s. a month. The quotations for the *No.* 1 brands of makers are the following: Gartsherrie, 72s. 3d.; Coltness, 72s.; Summerlee, 68s. 6d.; Calder, 67s.; Shotts, 66s.; Langloan, 65s. 6d.; Cambroe, 65s.; Glengarnock, 67s.; Carron, 65s. The total shipments of Scotch iron last week were 12,874 tons (foreign, 8408, and coastwise, 4466), as against 10,608 tons in the corresponding week of last year. The total increase since 27th December last is 123,842 tons over the shipments at the same time last year. Carron iron is now coming into the Glasgow market in considerable quantities; for foundries alone it is said that the deliveries are about 900 tons per week. The stock in Messrs. Connal and Co.'s stores at the close of the past month was 374,303 tons, with warrants in circulation for 361,500 tons, and in the Canal Co.'s stores 15,343 tons, with warrants for 14,252 tons.

The Finished Iron Trade.—This branch of trade is still exceedingly busy. Puddlers are so scarce that makers have to depend largely upon English masters for supplies of puddled iron. Wages are again going up. On Saturday last the Glasgow Iron Company gave a second rise within a few weeks, and other firms are seriously considering the propriety of following suit. In some instances the men are getting 10s. per ton, or 2s. 10d. where the turning up at the hammer is done by the shingler, in which case the extra 2d. falls to his share. The price of finished iron is very firm, notwithstanding the recent advance of 10s. per ton. Common bars vary from 8*l.* 5s. to 8*l.* 10s.; angle iron ranges from 8*l.* 15s. to 9*l.*; ship plates are quoted at 10*l.* 10s., up to 11*l.*; and boiler plates from 11*l.* to 11*l.* 10s.

Heavy Forging Trade.—The manufacture of heavy forgings is now an important feature in the industries of Glasgow; indeed, the facilities for carrying on this branch of the iron trade are so great, that orders come from far and near. This is especially true of the works of the Lancefield Forge Company, which are now quite overstocked with orders, and the managing director has to refuse orders. One that has practically been refused is an order for the forgings of a war frigate which is being built for the Prussian Government, and which is to be the largest war vessel yet constructed. The forgings, taken altogether, would cost some thousands of pounds; one of them, the stern frame, being about forty tons in the finished state, and others of proportionate size and weight. The company have been compelled to refuse the contract on account of the fact that the work is to be finished by the month of April next, while one of the pieces would probably be on a machine in the finishing stage for six months at least. It is scarcely to be expected that any other firm in this country will take the work in hand with any certainty of completing it in the specified time.

Anstruther Harbour Works.—Operations have at length been commenced for the purpose of strengthening the new East Pier. Part of the necessary staging has arrived, whilst more is daily expected. Workmen have begun to make the large wooden boxes in which the concrete blocks are to be prepared. These will be about 6 feet square; and as they will weigh from 15 to 25 tons each, it is fully expected that they will break the force of the waves before they strike the pier, and thus form a protection which, had this plan been adopted sooner, would in all probability have been the means of preventing the damage which was sustained during the last two severe gales.

New South Breakwater Works at Aberdeen Harbour.—These works are now being prosecuted with as much speed as circumstances will permit. The breakwater starts at a point a little to the south-east of the Torry battery, and stands almost directly north and south. The total length is intended to be 1200 ft., about one-third of it being 30 ft. broad, and the remainder 85 ft. broad. It was intended at first to make the structure of concrete blocks throughout, but a commencement was made with liquid concrete, and this method of building has proved to be so completely successful, that a length of 320 ft. has been formed in this way. It is in consequence almost one continuous block, and were it possible to build the remaining portion on the same plan, it is probable that it would be one of the strongest structures of the kind in the kingdom. The part now being built is a much more serious undertaking. Concrete blocks, weighing from 10 to 20 tons, are being made, and then sunk into their places by powerful steam cranes. The depth at low water at the extreme end of the breakwater is 25 ft. As submitted to the public loan commissioners, the estimated cost of the breakwater is 78,842*l.*, including 10,283*l.* allowed for contingencies; and the total sum already spent on the works is about 27,000*l.* It is expected that the erection will be completed in 1876.

The Tay Bridge Operations.—The activity displayed in connexion with the Tay Bridge operations is such as to inspire the utmost confidence in the ultimate successful accomplishment of the great undertaking. The land abutment—a heavy structure of very substantial masonry—is now completed to the height of the girders. It will have to be raised a few feet higher, and it is expected that this will be done by the end of this week. A decided advance has been made with the construction of the first three piers. The first of these is built on the edge of the cliffs with a concrete foundation. Above the foundation the pier is built to a height of some 30 ft.—the material employed being brick. The foundation of the second pier, which is on the beach, being uncovered by water at low tide, has also been formed, and it will be immediately pushed forward to completion. It is intended to prepare the heavy iron tubes, in which almost all the piers will be encased, on land, and, by means of hydraulic machinery, lower them into the places they are destined to occupy. The space inside the tubes is to be built up with brick, and the several parts of each column will be bolted together so firmly that the strength of the joinings will be equal to that of any part of the fabric. During the late storm it was feared that the temporary pier might be carried away, and to prevent as far as possible such an accident in the future the contractors intend to sink along the line of it a piling of the iron plates out of which the castings are made. In this way the violence of the tide on the temporary pier will be greatly neutralised. At present there are employed at the Bridge Works about 70 men, but this number will be largely augmented by-and-bye, and when the piers are being sunk, and all the preparing departments are occupied, the hands engaged will range between 200 and 250.

Consulting Engineer to the Greenock Harbour Trust.—At their monthly meeting yesterday the Greenock Harbour Trustees appointed Mr. W. R. Kinipple, C.E., to be the consulting engineer to the Trust, his fee being fixed at 300 guineas per annum, and commission on new works to range from 2½ to 4 per cent.

Fall of a New Suspension Bridge.—The Boatford Bridge, which was lately erected at Langholm, in Eskdale, near the Border, fell on Monday afternoon, having only been finished on that day. About 200 people were on it, and a photographer was in the act of photographing it when the fall took place through one of the chains breaking. The bridge was an iron and wire suspension one of 175 ft. span, and had a very handsome appearance. A London firm took the contract for the erection of the bridge, but it is understood to have been sub-let to a Leith firm. One or two of the persons on the bridge received slight injuries, but nothing serious occurred.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was a large attendance on 'Change at Middlesbrough, but little business was done. The prices were unchanged, 50s. per ton being paid for No. 3. Makers are doing their best to keep their customers supplied with pig iron, but the deliveries are not nearly so large as brokers and manufacturers desire. Ships are still detained at Middlesbrough for cargoes.

The Returns.—From the Cleveland Iron Masters' Association returns for August it appears that there are now 127 blast furnaces, only five of which are out, and 122 of which are in blast. Messrs. Bolckow, Vaughan, and Co. are building two at Eston, Cochrane and Co. are building one, B. Samuelson and Co. one, Gjers, Mills, and Co. two, at Middlesbrough. The Norton Iron Company are building one, the Consett Iron Company one, and the Rosedale and Ferry Hill Company two. The Lackenby Iron Company, Middlesbrough are building two, which are now nearly ready for blast.

The Finished Iron Trade.—Steady activity characterises the finished iron trade. The great manufacturing power is rapidly decreasing the rail contracts. Bars, plates and angle, are eagerly sought.

Shipbuilding.—On the Tyne, Wear, and Tees, the shipbuilding trade is exceedingly brisk. At all the yards there is as much work as can be got through for several months to come. Messrs. Backhouse and Dixon, of Middlesbrough, have recently been commissioned to build a steamer of upwards of 3000 tons, to trade between Norway and America. On Saturday, this firm launched from their busy yard the s.s. Thomas Vaughan, 190 ft. long, 26 ft. 9 in. beam, and 15 ft. deep. She will be fitted with compound surface condensing engines, 85 horse power, by Messrs. Black, Hawthorn, and Co., Gateshead. This steamer has been built to the order of Mr. C. E. Muller, and will be specially fitted for the iron trade between Middlesbrough and continental ports.

Engineering.—Throughout the North engineering is in a satisfactory condition. Marine engine builders are very busy. Messrs. Hopkins, Gilkes, and Co., of Middlesbrough, have obtained the contract for erecting the iron pier at Coatham, to which we referred last week.

The Nine Hours' Movement.—During the week 120 Norwegians have arrived in Newcastle-on-Tyne, and have proceeded to Sir William Armstrong's works, at Elswick. This will more than compensate for the Germans who left work last week, and returned to Berlin, and will go far towards checking the discontent amongst the other foreigners who are still in the factories. The masters will continue to import as many foreigners as they can procure until they induce some of the old hands in Newcastle to resume their places. Subscriptions in aid of the strike hands, however, come in from all parts, and this week the League are able to pay each man 7s.—1s. more than they have ever paid—and each child 1s. This is partly owing to the fact that the number of men is being reduced by so many obtaining work in other towns. The number of men on the books of the League is now 2114—67 fewer than last week. On Saturday another mass meeting of the men was held at Newcastle, and they again resolved to adhere to their original resolution to remain on strike until the nine hours' movement is adopted. Yesterday a letter was published in the *Newcastle Chronicle* from Mr. W. Digby Seymour, the Recorder of Newcastle, suggesting a settlement of the strike by referring to a Tribunal of Commerce and Conciliation. After conferences have failed, and the struggle has gone on so long, there is little hope, in the face of bitter feelings on both sides, of this suggestion being acted upon at present.

NOTES FROM THE SOUTH-WEST.

Llanelly Railway and Dock.—In the last session of Parliament, an Act was passed authorising the formation of a railway between Sunnybridge and Llandovery. This new line if made, will open a much shorter route to Hereford and the Midland Counties than now exists, and will improve the prospects of the Llanelly Railway and Dock. The directors of the Llanelly Railway and Dock have been authorised to borrow 20,000*l.* on mortgage under the power of the Llanelly Railway and Dock Act, 1860. By an Act of last session, the Swansea and Carmarthen lines have been formed into a separate undertaking, and they are now worked by the London and North-Western Railway Company. The staff of the Llanelly Railway and Dock has been reduced accordingly.

Newport (Alexandra) Dock.—The ordinary half-yearly meeting of this company was convened at 60, Gracechurch-street, London, on Thursday in last week, but it could not be held as only the secretary and the engineer put in an appearance. The works which the company has in hand are stated to be progressing satisfactorily.

Steam Navigation between Bristol and New York.—The screw steamer Arragon (of the Great Western steamship line), has left Bristol on her second voyage for New York, She took out 171 passengers and a general cargo. Her owners are thoroughly satisfied with the results of the first voyage made, and they are looking out for another steamer of about the same size but with more powerful engines to put on the line between Bristol and New York.

Bristol Harbour Railway.—This line will be ready for traffic in six weeks. The Great Western and the Bristol and Exeter Companies are both interested in the undertaking.

Bury Port and Gwendraeth Valley Railway.—At the half-yearly meeting of the shareholders of this company, the report presented stated that there had been an increase of 396*l.* in the revenue of the company as compared with the correspondingg half of 1870. The French, the report added, were great consumers of the economical smokeless coal which was found in perfection up the Gwendraeth Valley. During the last three months of 1870 and the first four months of the present year this trade received a great check from the war; but since the conclusion of peace, the aspect of affairs has again become more encouraging. Sinking for coal in some localities traversed by the line is still in progress, and a large quantity of ironstone is being raised. A branch line to Kidwelly will soon be commenced. Kidwelly quay, the property of Lord Dynevor, has been offered to the corporation of that place by his lordship.

Coal in the Rhondda Valley.—The period of compulsory inactivity enforced upon the colliery owners of the Rhondda Valley by the late strike among the steam coal colliers has been turned to good account. Since the turn-out of the men on the 1st of June, the Abergorky Colliery Company has been engaged in improving its workings by deepening the shafts of its pit at Treorky. In the course of this work, the excavators came upon a new seam of coal of fine quality.

The Port of Cardiff.—The quantity of coal exported from Cardiff to foreign ports in August was 102,062 tons, while the exports coastwise were 64,835 tons. The exports of patent fuel were 5001 tons. The iron exports of the month were 35,211 tons, of which 3533 tons went to Montreal, 5870 tons to New York, 2926 tons to New Orleans, and 5338 tons to Trieste.

Welsh Coal Abroad.—In the course of August, shipments of Welsh coal were made as follows from Cardiff to certain foreign ports: Alexandria, 3058 tons; Barcelona, 9059 tons; Constantinople, 4841 tons; Gibraltar, 4763 tons; Havre, 6580 tons; Monte Video, 5682 tons; and St. Nazaire, 9990 tons.

Trade at Newport.—Coal is now finding its way to the seaboard with greater regularity at Newport. There is scarcely any new feature to report in local trade.

Rhondda Valley and Hirwain Junction Railway.—The ordinary half-yearly meeting of the proprietors in this undertaking was held on Thursday in last week. It was stated that the works were progressing satisfactorily.

The Narrow Gauge in the West.—The narrow gauge is to be established between Radstock and Salisbury within twelve months. The Great Western directors are also thinking of laying the narrow gauge between Frome and Yeovil, so as to form a connexion with the narrow gauge lines at the latter place.

Trade at Cardiff.—The strike among the steam coal colliers of the Aberdare and Rhondda Valleys being at an end, the steam coal trade at Cardiff is recovering its position. Considerable supplies of coal have come down for shipment, and heavy clearances are expected to be made. The iron works continue well employed, principally on American orders.

The Forest of Dean.—Trade is active at the iron works of the Forest of Dean. At Parkend, a third furnace, recently blown in, is now in full blast. The demand for Forest iron ore is also brisk; besides the local consumption, heavy deliveries are being made to South Wales and Staffordshire.

The Nantyglo Iron Works.—Mr. Crawshay Bailey has resigned the active control of the Nantyglo Iron Works, with which he has been connected for 60 years. The works now pass, it will be remembered, under the control of a limited company.

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CONTENTS.

	PAGE		PAGE
Rauschinger's Indicator Experiments on Locomotives	151	Notes from the South-West	160
Wool Scouring and Dyeing	152	The Stowmarket Explosion	161
Technical Education	153	The Effect of Temperature on Coal Gas	161
Swing Bridge at Stettin	154	Railway Construction	162
Heating Railway Tyres	155	The Sewage Farm at Barking	162
The Stowmarket Explosion	156	East India—Progress and Condition	163
Recent Patents	157	Colebrookdale Works	164
Foreign and Colonial Notes	157	Notes from Paris	165
Shoeburyness Experiments	157	The Loss of H.M.S. Captain	166
The Stevens Institute of Technology, Hoboken, New Jersey, U.S.A.	159	Coopers Hill College	166
Notes from the North	160	Gunnean's Dynamotrical Governor	166
Notes from Cleveland and the Northern Counties	160	The Coalfields of Staffordshire	167
		Steam Boiler Legislation	167
		Civil Engineers and the P.W.D.	168

ENGINEERING.

FRIDAY, SEPTEMBER 8, 1871.

THE STOWMARKET EXPLOSION.

ALL who analysed carefully the evidence given during the inquest on the unfortunate sufferers by the recent explosion at the works of the Patent Safety Gun-cotton Company, at Stowmarket, will, we think, concur with the verdict returned by the jury on Wednesday last. In fact we do not hesitate to say that in the face of the evidence adduced no other verdict could have been returned with any show of justice. We have ourselves published in the present and recent numbers such a full abstract of the statements of the various witnesses that it will be unnecessary for us to enter into the details of the subject here; but it may be desirable that we should state the broad facts which the evidence has proved. In the first place nothing has been adduced to show that the faith of Messrs. Prentice in the general safety of the manufacture they were carrying on was in any way unfounded. There appears to be no doubt whatever that with reasonable precautions the processes of dipping, washing, pulping, passing the cotton through the poachers, and pressing, could be carried on without involving any greater risk of accident than dozens of manufacturing processes which are carried on in large towns without their safety being questioned. The process of drying undoubtedly involved a greater risk, but it was a risk which, by proper and very simple precautions, could be kept within reasonable limits, and the general tenour of the evidence goes to prove that these precautions were taken at Stowmarket. The only point relating to the Stowmarket works to which exception can fairly be taken was the arrangement for storage. We consider that in no case should the storage of large quantities of explosive materials be permitted in close proximity to a town or large works, and we would make no exception to this rule, even in the case of explosives which are ordinarily supposed to be "safe," unless they are stored in a manner which would render it impossible for them to be tampered with, or exploded even by culpable negligence. In making these remarks we do not wish to impute any neglect of proper precautions in storing to Messrs. Prentice. That they had unbounded faith in the inexplosibility, under all ordinary circumstances, of the material which they manufactured, is abundantly proved by the behaviour of two of the members of the firm, and of their manager, after the first explosion took place; but subsequent results showed that this faith was misplaced, and it is to the teaching of these results that attention should be paid.

As to the direct cause of the explosion there can, we think, be little doubt after the evidence which has been adduced. The analyses of the samples of gun-cotton taken from Upnor show conclusively that a portion of the gun-cotton—about 233 lb.—supplied to the Government from Stowmarket was in a state of decomposition, and that this cotton contained an amount of sulphuric acid, which was absolutely greater than that which the cotton would contain in the process of manufacture before passing the poachers. An 8 oz. disc of thoroughly good gun-cotton would, it was stated by Professor Abel, only contain $\frac{1}{10}$ of a grain of impurities; a sample of *unpulped* cotton, taken from the works after the explosion, only contained $\frac{1}{10}$ of a grain of sulphuric acid per 8 oz.; and yet in some of the cotton taken from the magazines at Upnor as much as 21 grains of sulphuric acid was found in an 8 oz. disc. The chemical evidence also went to prove that, from the alkali present, the impure cotton must have passed through the poachers where lime water is used for the purpose of neutralising the acid. Under these circumstances the conclusion naturally come to was that acid had been added to the cotton after its leaving the poachers, and the probability is that this addition was made prior to the drying process. How the addition was made, whether wilfully or by accident, it is at present impossible to say. If wilfully, it would be difficult to speak in sufficiently strong terms of such a villanous act; and if accidentally, we should be compelled to adopt the conclusion that the various processes were not conducted at Stowmarket with such precautions as were desirable. At present, as we have already said, however, no evidence has been forthcoming which would lead us to this latter conclusion.

In any case the Stowmarket explosion has taught two very important lessons, the first being that the explosion of what is believed to have been a comparatively small quantity of impure gun-cotton is capable of causing the explosion of a large quantity of other gun-cotton in contact with it, and, secondly, that it is desirable that gun-cotton should, in addition to being subjected to its present tests, be re-tested and carefully examined in a later stage of its manufacture, or, in fact, just prior to storage. Had this been done at Stowmarket there is little doubt that a terrible calamity would have been averted. Taken altogether, the inquiry of which we have been speaking in no way tends to diminish our faith in gun-cotton when properly manufactured, but it has served to point out more clearly what are the dangers to be avoided, and to enforce more strongly attention to the precautions already known to be necessary.

In conclusion we desire to say a few words respecting the unjust attacks to which Professor Abel has been subjected in connexion with this explosion at Stowmarket. Professor Abel has for many years past made explosives his special study, he has added vastly to our store of knowledge of such materials, and in the course of his inquiries he was led to invent a mode of treating gun-cotton in the course of its manufacture, which is undoubtedly of very great value. For this invention it is perfectly just that he should be paid, and we cannot consider that the fact of his being a Government official should be allowed to militate against his rights as an inventor. The Government has the right of making gun-cotton by Professor Abel's process, and it was supplied with cotton from Stowmarket at a price less than the ordinary market rate by the amount of royalty received by Professor Abel on ordinary gun-cotton, and these advantages are, we think, all that the Professor can be justly asked to cede as a recognition of the appointment he holds. It must be borne in mind that Professor Abel has by no means stood alone in his opinion as to the value of gun-cotton as an explosive. The material is one which has been subjected to a vast number of experiments by men of undoubted ability, and we cannot consider that the results they have arrived at have been upset even by the explosion at Stowmarket. The only fault we can impute to Professor Abel is that he did not, so far as we are aware, organise a systematic testing of the gun-cotton in its finished state before its acceptance by Government. This should have been done long ago, and we most earnestly trust that it may now be done at once. The impure gun-cotton which has been discovered at Upnor should have been discovered when it was first delivered.

THE EFFECT OF TEMPERATURE ON COAL GAS.

ABOUT a year and half ago we directed attention in this journal* to some experiments which had then been recently carried out at the University of Munich, to determine the effect of temperature upon the illuminating power of coal gas. In these experiments the gas on its way to the burner was passed through a U tube, which could be immersed either in a liquid having an elevated temperature or in a cooling mixture. The general conclusions arrived at were, as we explained in our former notice, that heating the gas increased, and cooling it diminished, its illuminating power, the relative illuminating powers at the temperatures of 288°, 212°, 64½°, 32°, and −4° being represented by the numbers 118, 104, 100, 85, and 40.

These results arrived at by the experimenters in the laboratory of the University of Munich have lately been controverted by the gas referees appointed to report to the Board of Trade on the construction of gas-burners, and whose first report has just been made public. Entertaining some doubts concerning the results of the Munich experiments as not being explicable on any known grounds, the gas referees determined to investigate the matter for themselves. The apparatus employed consisted of a coil of ¼ in. pipe 12 ft. long, which was submerged in a water-bath, a metal pipe 18 in. long, which connected the coil with the burner, being fitted at the middle of its length with a thermometer so placed that the gas passed over the bulb. At first, on the water in which the coil was placed being made to boil, the thermometer indicated a rise of one or two degrees only; and although oil was substituted for water, and the length of the coil was increased to 56 ft., the temperature of the gas rose to 79° only even when the oil was raised to its boiling point, or about 400°. It was at first inferred—erroneously as it turned out—that a greater amount of heat communicating surface was required, and large shot were placed in the pipe to conduct the heat inwards and give a larger surface of contact. This modification, however, made but a trifling difference; but incidentally it was noticed that the faster the gas was sent through the tube the greater was the rise of temperature, and this led the referees to the conclusion that the fault of the apparatus consisted not in its providing insufficient heating surface, but in its affording too great a facility for the cooling of the gas after it left the coil. Subsequently, therefore, the tube connecting the coil with the burner was surrounded by a jacket, which extended to within 2 in. of the point of ignition, the thermometer being placed between the coil and the burner as before, and in this arrangement, with the jacket filled with boiling oil, the thermometer indicated a temperature of 296°—a temperature slightly higher than that which was found by the Munich authorities to produce an increase of the illuminating power of 18 per cent. To test this result the gas referees provided a by-pass, arranged so that the gas could be sent direct from the meter to the burner, or through the heating coil at pleasure, it being possible to make the change instantaneously, so that any variation in the illuminating power could be readily noticed. The result was, however—to quote the words of the report—that "*the heated and cool gas gave exactly the same amount of illuminating power.*"

Here, then, is a conclusion diametrically opposed to that derived from the Munich experiments, and the question naturally arises which is right? This question is by no means an easy one to answer. It appears scarcely probable that the authorities at Munich, accustomed as they are to investigation in physical science, should have recorded such a noticeable rise in the illuminating power as 18 per cent., unless an important rise had really taken place, and the improbability of their having made an error of this kind is increased by the fact that

* *Vide* page 202 of our ninth volume.

their records of the increase of illuminating power, with the rise in the temperature of the gas, are consistent amongst themselves. But if the observations of the gas referees are received as decisive, an increase of the temperature does *not* produce an increase in the illuminating power, and the increase in this power observed at Munich—if it existed at all—must, if this view of the matter be accepted, have been due to some other cause than the rise of temperature. Whether such other cause existed, the Munich authorities alone can explain, and they owe it to themselves, and to the scientific world generally, that the point should be cleared up.

As far as deductive reasoning goes, the gas referees have undoubtedly many arguments on their side. It is difficult to imagine any reason for an increase in the temperature of the gas producing an increase in the illuminating power, unless indeed the amount by which the temperature is raised is something enormously beyond that reached either in the gas referees' experiments or in those at Munich. As the gas referees plausibly observe: "The only intelligible motive that there can be for heating gas when supplied to the burner is, that this preliminary heating may enable the gas-flame to acquire a higher temperature, and consequently burn with greater brilliance. But such a result cannot reasonably be expected; for the heat which gas acquires when ignited is immensely greater than any which in ordinary use can be imparted to the gas as it is supplied to the burner. . . . Indeed, as a practical question, *the only means of affecting the temperature of the gas at the point of ignition is by the shape and material of the burner itself.*" Neither the gas referees nor the Munich authorities give particulars of the description of burner employed in these experiments, and it is therefore impossible to eliminate the influence of this detail from the results, but it is possible that the gas referees may have employed a metal burner, which heated the gas supplied in a cold state before it reached even the point of issue, while at Munich there may have been used a non-conducting burner, which would not produce such a result. We say that it is *possible* that this may have been the case, but in the absence of more definite information it would be idle to argue upon such a state of affairs. Before taking leave of this portion of the subject, however, we deem it necessary to direct attention to one point connected with the gas referees' experiments, which we cannot but regard as somewhat doubtful, and which indeed throws a certain amount of suspicion upon the absolute accuracy of the observations. We allude to the assumed rapid cooling of the gas after leaving the coil. We are told in the report that the thermometer was inserted in the tube connecting the coil with the burner, midway between the former and the latter, or in other words—the connecting pipe being 18 in. long—9 in. from the end of the coil; and we are further informed that the gas was so cooled in traversing this 9 in., that the thermometer only indicated a temperature of 79° when the coil, 56 ft. in length, was immersed in boiling oil, whereas, when an oil jacket was applied to the connecting pipe, the temperature of the gas rose to 296°. Now if the gas was really heated during its passage through the coil, this supplementary oil jacket can scarcely have had much effect in increasing its temperature, but can merely have acted as a kind of protective shell, preventing the loss of heat. But if this was the case, the gas, on leaving the coil before the jacket was applied to the connecting pipe, must have had a temperature of about 290°, and it would appear that this temperature was reduced to 79°, merely by traversing the 9 in. of connecting pipe between the coil and the thermometer. In other words, it is assumed that although traversing 56 ft. of piping only sufficed to raise the temperature of the gas to within about 100° of that of the external heating fluid, the passage of 9 in. of exposed tubing sufficed to cool the gas down again to within about 15° of the temperature of the external air. This assumption is so totally opposed to all that is generally known concerning the absorption of heat by, and its radiation from, gases, that we cannot but accept the data set forth by the gas referees with a certain amount of reserve. If the burner used during the experiments burnt 5 cubic feet of gas per hour, the gas would traverse the coil of ½ in. pipe at the rate of almost exactly a foot per second, and if the diameter of the connecting pipe was also ½ in., there would thus be but ¾ second available for the cooling of the gas between the instant of its leaving the coil and that of its reaching the thermometer. Altogether there are some points about this portion of the experiments on which further information is desirable, and it would be especially satisfactory to know, in the first place, what would have been the effect on the thermometer if the connecting pipe had been merely well protected by a non-conducting coating, instead of by the supplementary oil jacket; and secondly, what means were taken to insure that no heat was directly communicated to the thermometer from the supplementary oil jacket when the latter was employed.

As regards the effect of cold on the illuminating power of gas, the conclusions of the gas referees are also at variance with those of the Munich authorities. The latter deduced from their experiments that when the temperature of the gas was reduced to 32°, its illuminating power was brought down to from 75 to 86—its illuminating power at ordinary temperatures being represented by 100—while, when the temperature was further reduced to −4°, the illuminating power fell to from 33 to 40. The gas referees did not experiment on the power of the gas at extremely low temperatures, but they came to the conclusion that cooling it to 32° had no effect on it. They say in their report:—"By means of the by-pass above-mentioned gas at the freezing point and at a temperature of 296° Fahr. was alternately supplied to the burner without making any difference in the readings of the photometer; so that the mere *cooling* of the gas (like the heating of it) has no effect upon its illuminating power." The referees, however, admit that a reduction in the temperature of the gas, accompanied by a reduction of the temperature of the air in which the gas is burned, may have a perceptible influence on the light-giving power, and they allude to the diminished brilliancy of the lights of street lamps in cold weather as supporting this conclusion. As regards the variation of temperature of the gas itself, however, apart from that of the atmosphere in which it is burned, the gas referees state that: "they consider that as regards the influence alike of heat and of cold upon the illuminating power of gas, it may confidently be stated that no effect whatever is produced, unless the heat or the cold is applied to such a degree as to alter the constitution of the gas. And, as a matter of fact, they found that no such change was produced between 32° and 300° Fahr.; in other words, within any range of temperature which needs be taken into account." They further conclude as a practical deduction from their experiments that "it appears that the advantage at present supposed to be derived from making burners of non-metallic substances (steatite, porcelain, &c.), in order to keep the gas at as low a temperature as possible at the point of ignition, is wholly imaginary. . . . The only advantage, therefore (and it is a considerable one), of using non-metallic substances in the manufacture of burners arises from their superior endurance, as they are not liable to oxidise like metal burners." Here, then, the matter for the present rests; but it is scarcely probable that the authorities at the Munich University will accept the complete reversal of their deductions without carrying out further experiments to either prove or disprove their original conclusions, or to explain satisfactorily the difference between the results arrived at by the gas referees and themselves. In any case we trust that the details of these further experiments, if carried out, may be fully made known, and we ourselves shall be most willing to give them publicity in our pages.

RAILWAY CONSTRUCTION.

We have suffered a great disappointment. For months past we had pleasurably, not to say eagerly, looked forward to a report on the railways of the world. In our imagination we had pictured a work which should be to us a thing of reference and a joy for ever; we dreamt of a voluminous volume, of endless statistics, of an atlas of plates, produced with the best skill Australia could command. Beforehand we felt grateful to the colony that was going to do so much for her mother country. But the reality has come upon us, and all our dreams have vanished, our anticipations have fled, our gratitude is recalled. For we have been made the victims of misplaced confidence.

But perhaps Australia is not all to blame. Victoria devoted money and time to achieve a great end, and that she has failed is owing to no misguided economy, but to the fact that the means selected for the end were not efficient. In 1869 the Commissioners of Railways in Melbourne instructed a Mr. William Eladon, who, we believe, holds some official position in connexion with the railways of Victoria, to proceed to Europe, to visit and inspect the railways of England and the Continent, and afterwards those of America, and to report on their mode of construction, equipment, and general management, in short, to furnish the Commissioners with such information as would make them acquainted with existing railway practice in all its details, with the view of assisting their deliberations on the railway future of the colony. All credit to Victoria for this grand idea, which no other country has had the enterprise to undertake, and all credit to them for the generous manner in which they devoted the necessary funds for this undertaking. Alas! that one element was wanting to the completion of the task—brains. Not that we would for one moment infer that Mr. Eladon lacks that organism necessary for the development of thought. Probably he is a very clever man—he ought to be, since he was elected a member of the Institution of Civil Engineers last year, and the Council of that body are very cautious. We mean only that Mr. Eladon did not use his brains, nor his eyes, nor his opportunities; or if he did, he has not given any indication of the fact in his report to the Honourable the Commissioners of Railways for Melbourne. In fact, how the former could offer and the latter accept such a wretched affair as this same report passes our comprehension. Here is a man, Mem. Inst. C.E., occupying a responsible position in the colony, receiving almost unlimited privileges in time and money, travelling probably 70,000 miles, the accredited agent of a Government, with every facility for inspection and information open to him, with introductions everywhere, and hindrances nowhere, despatched on the most interesting and really charming work an engineer could conceive, who spends nearly two years of the Government time, and we don't know how much of the Government money, and ultimately submits a so-called report seven and a half pages in length, in large type, with a broad margin. Reading it, however, we are really and truly thankful it is not longer. But justice to Mr. Eladon. There is something more; he has taken back with him statistics, pamphlets, drawings. Doubtless all that is to be desired will be found in them. I furnish you, Mr. Commissioners, he says, "with a series of appendices containing the statistics of the principal lines in the above-named countries, together with drawings and photographs of improved rolling stock and railway plant, and pamphlets relative to railway gauges, and bogie engines, &c."

So, we thought though we have it not in the report, at least Victoria is rich in railway information. And in this belief we might have remained, had we not seen the list of pamphlets, of drawings, and the statistics, which it appears are, after all, appended to the report. The pamphlets relating to narrow gauge railway are nine in number, seven of which have been written by or refer to Mr. Fairlie, and the other two have nothing to do with narrow gauge at all. The remaining pamphlets are, to a great extent, time tables of different lines, which, if they are of any value at all, are always obtainable through the post by the railway commissioners. Of the drawings supplied we note Mr. Fairlie's contributions again, a photograph of Krupp's works at Essen, and a number of inventors' lithographs. Of the statistical tables we will speak by-and-bye. Besides all this rubbish, there is attached to the report two letters by Mr. Higinbotham on Australian railways, Mr. Bidder's report on the change of gauge on the Lahore and Peshawur Railway, published by us many, many months ago, Mr. Hawkshaw's report on change of gauge in India, and a curious report by a Mr. Meikle, who appears to be a sort of mechanical backwoodsman, to whom the pen is a fearful and wonderful implement.

Now, if the Honourable the Commissioners for Railways at Melbourne had selected an office lad of moderate capacity, and shut him up with ink, pens, paper, and a file of Engineering, he ought in a week to have turned out a report of far greater value than the one under consideration, relieved, moreover, of its conclusions, not an inconsiderable advantage.

We wish we could write differently of this matter; we have every respect for Mr. Eladon, and no possible feeling of ill will towards him, except that engendered by the consciousness of disappointment; but when we see what has been produced, and think of what it might have been,

we grow impatient. Fifty-five clauses there are, and the less said about all of them the better; eight recommendations there are, all of which might have been made without Mr. Elsdon stirring a foot beyond his colonial front door. Of course Mr. Fairlie's name is dragged in, it always is. Whether fortunately for that gentleman or otherwise, your colonial railway man cannot speak or write a hundred words on narrow gauge without doing so, generally, as it happens, for abusive purposes; not that Mr. Elsdon has been by any means abusive; on the contrary, his criticism is mild and harmless. He points out that the Fairlie engine, as at present built, "has many serious defects which must be remedied before it can compete with the ordinary bogie engine for general traffic, although it may perhaps be used with advantage on steep gradients with exceptionally sharp curves." In other words, a machine which, in his opinion, has radical defects rendering it unfit for ordinary and straightforward work, may be nevertheless suitable for duties of the heaviest and most difficult nature.

And this reasoning is characteristic of the whole production; it is, moreover, in keeping with the absolute statements of the report. We are told that the Americans have solved the problem of cheap railway construction through thinly populated districts, and this statement is based upon three facts previously stated, namely, the adoption of level crossings, the absence of gates and fencing, and the use of timber in bridges and viaducts. That he has passed by the great feature of cheap railway construction in America is a proof either of his indifference in investigating the subject, or his inability to do so. There is another great fact with regard to American railways too good to be passed over. In the United States, we are told, the use of hard ballast is the exception rather than the rule, *several hundreds of miles* being laid through districts where ballast was too costly to be laid down. What does Mr. Elsdon mean by several hundreds—ten hundred, or fifteen hundred, or two thousand miles, if the use of ballast is the exception rather than the rule, and several hundred miles are without it in the States? Any one totally ignorant of railway statistics in America would gather that the United States railways' mileage was less than a thousand.

But in his suggestions upon change of gauge Mr. Elsdon is out-Elsdonised. After setting forth a number of the old reasons and arguments against narrow gauge, all of which are so threadbare that we had trusted they were worn out by this time, the reporter suddenly advocates the adoption of a width of 4 ft. 8½ in., although the standard gauge of the colony is 5 ft. 3 in. Why this conclusion we know not, nor are we quite clear whether he refers only to future extensions, or a shifting of the gauge of existing lines; if the former, he upsets his arguments against break of gauge; if the latter, he counsels the abandonment of all the existing stock in the colony. And if a change is made at all, why 4 ft. 8½ in.? What special virtue is there in a reduction of 6½ in. to warrant its adoption? Only two shadowy reasons are advanced, one, because the 4 ft. 8½ in. gauge "gives ample stability for the most powerful class of engines in use," the other, because rolling stock 7 ft. 6 in. wide can be employed. He evidently does not know that rolling stock of this width can also be employed on lines much narrower than 4 ft. 8½ in., and engines of any given power can be placed on gauges of any width from 3 ft. and upwards. But we are weary of following Mr. Elsdon through any more of his unfortunate flounderings. He clearly is totally innocent of any knowledge whatever on the gauge question; and if he possessed the necessary information and the ability to use it on the rest of his report, he has not availed himself of those advantages.

The reports of Mr. Higinbotham, engineer-in-chief of the Railways Department, Melbourne, which are appended to Mr. Elsdon's production, are worth a passing notice, as they deal with the proposed railways extension of Victoria. Mr. Higinbotham sets his face entirely against the adoption of a narrow-gauge railway, basing his objections almost wholly upon the evils of break of gauge. He estimates the economy that would be effected by adopting a light system on the standard gauge, and upon a similar form of construction, on a width of 3 ft. 6 in., and he shows that a saving of 1454*l.* a mile, in the first-named, and 1959*l.* in the second, could be effected by the adoption of one or other of them, instead of by the existing system. He then proceeds to point out that, as the difference between the cost per mile of a light 5 ft. 3 in. and a 3 ft. 6 in. is only 540*l.* a mile, the economy effected will be insignificant as compared with the inconveniences resulting, and he then says that, "as very exaggerated statements are constantly being made of the saving which might be effected by adopting for this country (Australia) railways of light construction on a narrow gauge, I think it desirable to put forward the result of my calculations on the subject."

We do not know where these calculations are put forward; certainly they don't appear at all in the report, the remarks above quoted being immediately followed by extracts from the reports submitted by Mr. John Fowler and Messrs. Strachey, Dickens, and Rendel to the Indian Government last winter. We freely grant, however, that Mr. Higinbotham's "calculations" may be correct, and that in making a 3 ft. 6 in. railway suited to the requirements of the colony he would save 2000*l.* a mile, as compared with constructing one of the existing standard type. But this saving on the 181 miles of proposed line would be 362,000*l.*, no inconsiderable economy we should imagine for an Australian railway. But such a course would involve necessarily a break of gauge, and to avoid this Mr. Higinbotham proposes an intermediate course, as ingenious as that of Mr. Elsdon, when he suggests that to avoid the evils of narrow gauge a reduction only of 6½ in. should be made. Mr. Higinbotham proposes the adoption of "the lightest possible works" on the 5 ft. 3 in. gauge, over which he proposes to run the existing heavy Victorian railways rolling stock, forgetting that for such a class of lines as he proposes, special rolling stock is as necessary as for a narrow gauge; and his suggestion, if carried out, would involve either the sacrifice of material that has cost some 700,000*l.*, or all the inconvenience of break of gauge in one direction of the traffic.

It requires but small consideration to understand the utter fallacy of his arguments. Apparently the heads of the railways department appreciated them at a proper value, as we note in a later report in which Mr. Higinbotham, alarmed at the serious discussion that was taking place with reference to a change of gauge in the Victorian extension, falls back on his last resource, and points to the difficulties and delays that must inevitably take place, the loss of money that must certainly ensue; if his plans partially executed are not completed, whilst after all the loss of time involved—a year at least—when Victoria does obtain the new lines, they will be accompanied by break of gauge, "an evil, the magnitude of which is not appreciated here, because it has not been experienced." We trust Mr. Higinbotham's gloomy forebodings may be fulfilled, and that the people of Victoria may realise all the horrors of a break of gauge, and we believe that if such a fortunate result ensues, that Mr. Higinbotham will be one of the first engineers in the colony to admit that his favourite theories on the subject are at fault, and that both in first cost of construction, and in subsequent cost of working, narrow gauge lines are the most suitable for the colony.

THE SEWAGE FARM AT BARKING.

THE Barking Sewage Irrigation Farm was visited by the members of the Society of Engineers on Monday last, the party being conducted over the works by Mr. J. Morgan, the resident manager. This farm has now been in successful working for five years; it has an area of 220 acres, to which further additions are about to be made. At the present time about 160 acres are under irrigation, and are producing excellent crops of Italian rye grass—some of which is being cut for the sixth time within twelvemonths—cabbages, swedes, mangold, onions, &c. The sewage is taken from the outfall at Barking, near which point—about one mile from the farm—it is intercepted and pumped up to the works. For this purpose two 25 horse power pumping engines are employed. The sewage passes through a wire screen on its way to the pumps in order to free it from paper and other objectionable matter which formerly found its way on to the land, of course to its detriment. From the pumping station the sewage is forced through a 15-in. main to the head of the farm, which stands at a level of 25 ft. above the pumping station. Here it is delivered into three sets of carriers, which can be worked together or independently of each other, as required. The carriers have a total length of two miles, and are led to various points on the farm. The upper carrier is of iron, semicircular in section, and situated at a height of about 15 ft. from the ground at the head of the farm. The intermediate carrier is of wood, and is at a level of about 7 ft. below the upper one, both being carried in the same framing, which is of timber. The lower carrier is nearly on a level with the ground, and conveys the sewage to another section of the farm.

The ground is laid out in beds and gutters, the largest beds measuring 150 ft. over all, and being laid with a fall of 1 in 69 in 75 ft. on either side of the carrier, the fall of which is about 1 in 500. The smaller beds vary in size, ranging from 36 to 50 ft. over all, and having an average fall from ridge to furrow of 1 in 30. The greatest fall in the supply carriers varies from 1 in 110 to 1 in 617. The sewage has a maximum flow of 75 ft. per minute, and the quantity used on the farm at the present time is at the rate of 600,000 tons, or 134,400,000 gallons per annum. This apparently large consumption, however, forms but a small proportion of the sewerage of London, being in effect only equal to two days' delivery. Although the farm is in itself a very successful practical exponent of sewage irrigation, and although the crops appear highly satisfactory, still the yield during the present season has been somewhat behind that of previous years. This is accounted for by the fact of there having been so much wet cold weather in the spring and early summer, which kept the crops back. What was required was a slight dressing of manure to counteract the chilling effects of the sewage drenching under the influence of cold weather. This requirement will in future be met—should the necessity arise—by the use of manure from the farm itself, which is now being stocked to some extent with beasts. The condition under which sewage farms thrive and pay best—other things being equal—are those of sun and drought. With a hot, dry season, sewage judiciously applied proves of inestimable value. What the profits are at Barking we are unable to say, inasmuch as the company to whom the farm belongs are expending a considerable amount of money in the reclamation of some adjacent lands. The visit of the society was instructive and interesting, and despite the rain, which fell plentifully, the ramble over the Barking sewage farm was appreciated by all present.

EAST INDIA—PROGRESS AND CONDITION.

UNDER the above title there is annually presented to Parliament a "statement exhibiting the moral and material progress and condition of India." That for the year 1869-70 is now before us. When these reports were first commenced, in 1864-65, the subject matter was arranged under the several heads of "Revenue," "Finance," "Public Works," "Judicature," &c., and one was able to comprehend readily the real condition and prosperity of the country on the whole under any one of the several heads of administration; for the last three years, however, this arrangement has been changed, and the report has since been arranged under the headings of the various local governments and administrations, which renders it far less convenient for reference than it was in the old form, and makes it more difficult to appreciate the rate of progress under any one branch of the Legislature; thus, at first glance, it would appear that very little had been done in the construction of Public Works, though such is by no means the case, notwithstanding that a less expenditure on that account was incurred during 1869-70 than in the preceding year. In order to arrive at what was accomplished, however, it is necessary to wade through 91 pages of print, extracting a few facts here and a few there, in order to complete one's information on the subject. For the convenience of our readers, we shall now proceed to classify the subjects suitable for notice in this journal, according to their denomination, under the headings of expenditure, roads, bridges, railways, canals, and municipal works.

"The year 1868-69," we are told, "closed with an excess of expenditure over income of 2¾ millions; the year 1869-70, with an excess of income over expenditure of 118,669*l.*, excluding, in both years, those public works which are constructed by means of loans, and are termed 'extraordinary.'" Such a statement, although undoubtedly put forward in good faith, does not appear to be absolutely correct, and that there was during the year a large

deficiency instead of a surplus, notwithstanding the efforts made to produce an equilibrium of the finances by reducing the grants originally made for public works, and by increasing the income tax. We are justified in making these remarks in consequence of the amendment proposed by Mr. Fawcett to the Report from the Select Committee on East India Finance, of which committee he is a very active member. This amendment, though not adopted, is printed with the Committee's Report, and no doubt embodies an expression of facts elicited by the Committee. It is to the following effect: "Your Committee have reason to believe, from the evidence given by the Controller-General of the Finances, at Calcutta, by the Financial Secretary to the Home Government, and other witnesses, that many items of receipt are put down to income which ought properly to be considered as capital, and to be devoted to the reduction of debt. In the year 1869-70, when there was a supposed surplus of 118,000*l.*, items, amounting in the aggregate to more than 1,200,000*l.*, were thus devoted to income instead of being regarded as capital. The Controller-General admitted, in reference to these facts, that instead of there being a surplus of 118,000*l.*, there was a very considerable deficiency, &c." The expenditure on public works ordinary, during the year, including supervision and cost of land for railways, and loss by exchange on railway transactions, was 5,107,259*l.*, or 1,326,258*l.* less than in the preceding year. The expenditure on "extraordinary" works is not—from some unaccountable oversight, it is presumed—mentioned in the Report, for these "extraordinary" works, which include State railways and new irrigation projects, will henceforth form one of the most important items in Public Works Expenditure, as the works themselves will also be amongst the most useful and important for the welfare of the country. Some idea of the importance which India is to England may be gathered from the fact that the expenditure in this country on account of the Indian Government amounts to about 6½ millions, and that in addition stores to the value of nearly 1½ millions were sent from England to India by Government during the year. A large deficit still remains to be made up out of imperial revenues on account of the guaranteed interest on Indian railways, the amount of interest so paid, less net traffic receipts, amounted to over 1½ millions in the year. As these railway shares and stocks are principally held in this country, it may be stated that at least 9½ millions sterling, out of a total revenue of 50¾ millions, was remitted by India to England. We have on previous occasions commented on the Indian telegraphs, and the yearly cost they are to the State; during the year now under notice the expenditure under this head appears to have been about a quarter of a million sterling in excess of receipts. The receipts from Public Works are set down only at 957,714*l.*, but when we turn to the section relating to Madras, and find that, notwithstanding the enormous extent of her canals and irrigation systems, Public Works receipts are set down at only 46,971*l.*, it is clear that there must be an error somewhere. This error may be traced to the difference of systems that prevail in various parts of India, for whereas in some parts the revenue derived from irrigation is collected by, and therefore credited to the Public Works Department, in others, and notably in Madras, a different system prevails, and such collections are made by the revenue authorities, and the receipts credited to land revenue.

From expenditure we turn to the administration of the Public Works Department. It has been usual, it appears from the report now before us, for the Governor-General of India to superintend the political business of the Foreign Office; but Lord Mayo, since he entered on office, has, in addition, taken under his special charge the department of Public Works, which at that time had no recognised head in the Council. He is now directing his attention to the introduction of a better organisation into this important branch of the administration, and this subject seems also to have attracted the attention of some of the senior officers of the Department. The Chief Engineer in the North-Western Provinces has made some valuable suggestions in his remarks on the constitution of the Department. He would relieve Executive Engineers of divisions from all management of the accounts part of the business, by giving them a better class of accountant, so that their whole time might be devoted to supervision and management of works; he would, in a great measure, transfer the preparation of projects from the executive engineers to the superintending engineers of circles, and he would bring the latter into closer connexion with the head of the Department, whose time is, to a great extent, taken up with corresponding with those officers at a distance, to the detriment of his larger administrative duties.

Too great importance cannot well be attached to the improvement of means of communication, and although railways are undoubtedly the best of such means, their extent must be limited by circumstances; their very prosperity is dependent upon the existence of roads to act as feeders, and the largest possible amount of available funds may therefore be profitably laid out on such works. In the revised budget for the year about one million sterling was allotted for the purposes of communications, but it does not appear, from the report now before us, how much was actually expended. Beginning with the provinces directly under the supreme Government, it appears that in past years considerable amounts have been expended on roads in the Hyderabad assigned districts, known better as the Berars; the Great Indian Peninsula Railway runs right through these districts by means of which its products are carried off rapidly and cheaply to the great centres of trade. The result of British administration is shown in the fact that in less than ten years the revenue of these districts has been raised by 280,000*l.* per annum. Throughout the remainder of Hyderabad, which is also known as the Nizam's dominions, to distinguish it from the Berars, roads are far from what they ought to be, there being as yet no regularly made first-class road, in the common sense of the word, in existence. Such roads as there are are fair during the dry weather, but become almost impassable during the rains. In Mysore about one-third of the entire outlay on public works was expended on communications. The aggregate length of roads in charge of the Public Works Department in Mysore was 2365 miles, besides which there are numerous district roads throughout the province, which are under the control of the district officers, and are maintained by local funds. Great attention is here given to the planting of avenue trees along the roads. In the Lower Provinces of Bengal water communication is very general, but notwithstanding this 210,000*l.* was laid out on communications, consisting principally of roads, and two important bridges at Kidderpore and Barrackpore—the one crossing over Tally's Nullah, and the other over the Circular Canal were completed. The retrenchment of about 180,000*l.* out of a budget grant of 762,500*l.* paralysed the department of Public Works in many of its most important branches, and only 114,000*l.* was spent on communications, none of them, however, being of such importance as to deserve special notice. In Oude, on the other hand, considerable progress was made under this head, 858 miles of new road having been constructed at a cost of 58254*l.* The Central Provinces are greatly favoured with facilities for railway transport, and its necessities have naturally led to the development of the roads of the country. The Nerbudda valley has now, we are told, all that it needs in the way of communications, and in the central plateau of the Sautpooras the road lines of provincial importance are completed or in progress. In the west the cotton country up to Nagpore is opened out by the Nagpore branch; but there still remains unprovided for the south-eastern half of these provinces, and in particular the great grain country of Chutteesgurh. Already the traffic on the imperfect road between Raepore and Nagpore is enormous, as many as 2082 carts having passed in eight days from west to east, and 3987 from east to west, besides some hundreds of pack bullocks. A scheme for the construction of a light railway between Raepore and Nagpore has been prepared, and submitted to the Supreme Government. An important treaty has been concluded with the Maharajah of Kashmeer for the abolition of transit duties on all goods passing between Eastern Turkistan and British India, which cannot fail to have the effect of largely increasing our trade with that State. In the native States of Bhawalpore and Chanda, good progress has been made in the construction of roads and bridges. In the Punjab, besides the expenditure from Imperial funds, no less than 33,310*l.* was raised from local funds and expended on communications. In British Burmah, a country more than three times as large as Scotland, possesses at present only 655 miles of road altogether, of which 124 are first class and 374 second class. The great want of the province in this respect is fully recognised by the local government, who are pushing forward the works with all the means at their disposal, and have submitted to Government an elaborate scheme of roads for the province. In the Madras Presidency, 96,285*l.* was expended during the year on new roads, of which a considerable portion was laid out in improving the communications of the coffee-growing district of Wynaad with both the western coast and the interior. The work is a very important one, and has encountered some delay. Some progress has also been made with the navigable canals of the Presidency; in the north, the canal connecting the Chilka Lake and the Ganjam river was opened to traffic; the Cheyaur Channel was deepened; the extension of the East Coast Canal northwards to Kistnapatam was advanced; and the main canal between Negapatam and Vadaraniem is nearly complete. The improvement of the Paumben Channel also proceeded slowly. The subject of Public Works in Bombay is passed over in a manner of which the subject is wholly undeserving. With a total expenditure, ordinary and extraordinary, of 1,380,000*l.*, it is hardly sufficient to state that with regard to "the numerous items included under the head of Public Works, they, each and every one, were vigorously carried on towards completion, with the reduced grants to which Bombay, in common with the rest of India, had to submit."

(To be continued.)

COLEBROOKDALE IRON WORKS.

Referring to the industries of Shropshire, a quaint old writer, one Thomas Fuller, gave the following particulars, in which he unquestionably predicted the use of coal in blast furnaces: "Coal, one may see a threefold difference in our English coal; (1) the sea coal brought from Newcastle; (2) the land coal at Mendip, Bedworth, &c., and carried into other counties; (3) what one may call river, or fresh water coal, digged out in this country at such a distance from Severn that they are easily ported by boat into other shires. Oh! if this coal could be so charmed as to make iron smelt out of the stone, as it maketh it in smith's forges to be wrought in the bars! But Rome was not built all in one day, and a new world of experiments is left to the discovery of posterity." Although Shropshire has been one of the ancestors of iron manufacture in England, in the year 1816 the iron trade there was at so low an ebb that the advisability was, at one time, actually discussed of pulling down the houses and selling the bricks, for it was thought that the iron trade would never more raise its head in Shropshire; the times, however, improved, and we now see the same old works that cast "potts and kettles" in 1714, still employed upon the same useful operations. The coal-fields of Shropshire have now been in operation for about 550 years, according to a statement contained in a curious old book called "The Antiquities of Shropshire," wherein it is affirmed that in the year 1322, there was granted to one Walter de Colbroke, a license for one man to dig sea coal for one year in a place called Brock Holes, situated near the outcrop of the coal seam of the district, for which the said Walter de Colbroke was to pay a royalty of 6*s.* per annum. From this early speculator in coal mining, Colebrookdale has no doubt derived its name.

The iron works at Colebrookdale, which were recently visited by the members of the Iron and Steel Institute, are amongst the oldest, if they are not actually the oldest works in this part of the country. They are supposed to have been in existence from about the year 1600, and an iron bar or beam was exhibited bearing the date 1609, with the initials T. R. W., and another with the date 1630, with the initials T. A. There is also a cast-iron beam to be seen in the works, which formerly supported the brickwork of one of the furnaces here, bearing the letters E. L. B. W., and the date, 1658, cast in relief upon the face of it.

This furnace was removed by Abraham Darby, in 1777, and it is supposed that the first was transported here from an old charcoal furnace at Leighton. There appears to have been a work or a "smethe" here from the time of the Tudors. The books of the company, still preserved, show that as early as November, 1667, six tons of rails were cast, which were afterwards used by being laid down upon pieces of timber, and specimens of these

early rails of iron and wood were shown. One version of the affair is, that the iron market being depressed that year, the company, to keep their furnaces in operation, resolved upon making these bars instead of pigs, intending to take them up and send them into the market if a sudden rise in the price of iron took place; but they were found to answer so well that they were retained for local use, and rails have continued to be used in the iron district here from their first introduction, facilitating the transport of heavy materials from place to place. The early productions of the works were iron pots for domestic purposes, and these appear to have formed the staple manufacture at the time that the first Abraham Darby removed here from Bristol in the year 1709. This is shown by an old article of agreement between one Thomas Lucenck and Abraham Darby, of Colebrookdale, bearing date the 13th of June, 1714, whereby the former undertakes to "diligently and faithfully serve the said Abraham Darby and Co., and their assigns, in the art or mistery of making or casting of Iron Potts and Kettles," &c. In the museum at Colebrookdale were exhibited, amongst other things, a cast-iron rail and wheel, the former of which was laid down by Abraham Darby about 1760, "and between that and 1765 nearly 20 miles were laid down." Two of the most notable undertakings for which this place is celebrated were the laying down of the first iron rails, by Richard Reynolds, and the construction of the first iron bridge, by Abraham Darby, in 1779. This latter spans the Severn in one arch, about a mile from the Colebrookdale Company's Works. This bridge was cast at Colebrookdale in 1778, and erected during the two following years. It consists of a semicircular arch of 100 ft. in diameter, height 45 ft., and resting upon masonry piers which raise the soffit of the arch to a height of 55 ft. above the water level. It is composed of five ribs placed 6 ft. apart, covered with strong iron plates, which support a roadway 10 ft. wide.

Besides the introduction of iron rails and the construction of the first iron bridge the Colebrookdale Works are justly celebrated for having introduced other inventions of no less importance. To the same William Reynolds, who cast the first iron rails, the invention of a locomotive is attributed, before the machine invented by Trevethic travelled for a short time, at a slow rate, with heavy loads, at Merthyr, and, it is believed, even before Symington exhibited his model of the steam carriage at Edinburgh. A fatal accident, however, happened upon starting the machinery of Reynolds's locomotive, and it was therefore abandoned. Another invention of Reynolds was the well-known inclined plane at Coalport, which was devised by him for the purpose of overcoming the irregularity of the surface when canal navigation was of much more importance to the iron districts of Shropshire than at present, and by means of which boats laden with coal or iron were let down from one canal to another 207 ft. below, the lower one being close upon the banks of the Severn. The first iron boat is also said to have been constructed here, and was employed for the conveyance of coal on the Severn.

The old blast furnaces at Colebrookdale were formerly supplied with blast by water power, but when the use of steam was first substituted for this purpose some thirty years ago, a single cylinder steam engine of 12 horse power was erected at the works, and connected by means of gearing with the old blast cylinders, which still continue to raise blast for the cupolas. One peculiar feature in these works is that they employ a hot blast for their cupolas, and have done so now for upwards of twenty years. At another part of the works is a second blowing engine, also of ancient construction, but which is connected by beam direct, in the usual manner, with the blowing cylinder. Owing to the nature of the works constructed here, which consist chiefly of "iron potts" as of ancient time, vases, sewing machines, park gates, ornamental railings, and such like, much heavy machinery is not required. It is, however, for the excellency of the work which they turn out, and the peculiar fineness of their castings that the Colebrookdale Company are chiefly celebrated; and although they possess appliances for turning out heavy castings, which will be still further added to on the completion of the additions now in hand, their well-deserved notoriety is for quality of the work turned out, rather than to its weight and size. This company, as has been already implied, used at one time to make its own pig iron, but they have long since ceased to do so, and their blast furnaces appear to have been finally blown out soon after the introduction of steam in the place of water power.

NOTES FROM PARIS.

PARIS, Sept. 4, 1871.

THE LATE DR. BOUCHERIE.

DR. BOUCHERIE has just died at Bordeaux. The following are some extracts from an address delivered over his grave by Dr. Casenay, member of the Academy of Medicine. Dr. Boucherie, born at Bordeaux in 1801, obtained, at Paris, the degree of doctor of medicine in 1830. After having taught chemistry at Bordeaux, he was called to Naples to construct the first beetroot sugar works established there. After his return, in 1833, he undertook a series of investigations on the preservation of wood. The essay published by him on this subject in 1840 received great attention in the scientific world. His process consisted, as is well known, in "metallising," in some degree, the wood by the injection into its tissues of metallic solutions, amongst others, a sulphate of copper. M. Casenay stated that, following the meeting of the Institute when this paper was read, two large manufacturing establishments offered to purchase from M. Boucherie all his patent rights for the sum of 500,000 francs, which offer the inventor, although in straitened circumstances at the time, refused as insufficient.

However this might have been, the publication of his process at first only inspired incredulity, which time alone successfully triumphed over. M. Boucherie continued his experiments undiscouraged; he had to conduct tedious actions for infringement; and, in the end, he successfully surmounted all his difficulties, and the success of his process became fully established. From this time the change in his career commenced. Telegraph companies adopted his invention wholesale for the preservation of posts, and railways employed it for their sleepers. Dr. Boucherie also carried out his patents for dyeing timber, and others to make it incombustible, to dry it easily, and to render it of greater strength than in its normal condition.

At a later period he turned his attention to the preservation of animal substances from decay, and of utilising them for, and of transferring them into, a manure of small volume, and of a power greater than that of guano. He was fortunate enough to attain this threefold object by the aid of chlorhydric acid. The economical process of extracting starch from potatoes is also due to Dr. Boucherie, as well as interesting investigations on the preservation of meat and vegetables. Despite all the difficulties and drawbacks that attended his long and hard-working career, recompense was not lacking. At the various exhibitions he received many gold medals; he obtained, in 1855, the grand medal of honour; he had been elected chevalier of the legion of honour in 1840, and received promotion in 1856.

THE EMPLOYMENT OF ALLOYS.

M. Dumas has presented to the Academy of Sciences, in the names of MM. Montefiore-Levi and Künzel, a work having for its title, "Essays on the Employment of Various Alloys, and Especially of Phosphoric Bronze for the Casting of Ordnance." The following are the principal facts presented by M. Dumas.

From all time it has been recognised that the oxidation of tin during fusion was destructive to the quality of bronze, but even up to the present time this has been opposed by the stirring up of the molten metal with wooden rabbles. The oxide of tin, which of itself has no strength, separates the molecules of the alloy, and reduces its power of resistance. The employment of phosphorus as a reducer, gives remarkably uniform results; the oxygen of the tin oxide, is absorbed, and the resulting phosphoric acid forms, with the copper, phosphate of copper, which passes away in the scoria. Also, whilst ordinary bronze, submitted to the action of successive remelting, becomes more and more impoverished of tin, the phosphoric bronze can be cast over and over again without losing its proportion of tin. It appears to form itself as a fixed phosphate of tin, containing an equivalent of phosphorus and 9 of tin.

By a series of prolonged trials have been ascertained the properties which the phosphorus communicates to ordinary bronze. The characteristics of the alloys change. The colour, when the proportion of phosphorus exceeds ½ per cent., becomes warmer, and like that of gold largely mixed with copper. The grain or fracture approximates to that of steel. The elasticity is considerably increased, the absolute resistance under a fixed strain becomes in some cases more than doubled; the density is equally increased, and to such a degree that some alloys are with difficulty touched by the file. The metal when cast has great fluidity, and fills the moulds perfectly in their smallest details. By varying the dose of phosphorus, the particular characteristic of the alloy which is most desired can be varied at will.

The author proceeded to experiment in phosphoric bronze with a 6-pounder gun, which they submitted to destructive trial in comparison with a similar piece in ordinary bronze, cast by the royal foundry at Liége. From the results of these trials taken at various times during the firing, it results that the durability of the gun of phosphoric bronze is very superior to that of the gun of ordinary bronze, and that with bursting charges, which broke the latter piece into fragments, the former could still be fired with perfect safety. The bronze employed had been obtained by the addition of phosphoric copper to metal provided out of the guns.

The new bronze prepared under suitable conditions of composition and melting, can be rolled out and hammered with the greatest ease, without losing its tensile strength. Cartridges that can be loaded and fired 30 times may be formed from it.

The mechanism of breechloaders has also been made from this material. Six thousand rifles fitted in this manner have been supplied to the Belgian Civic Guard. Of the same material also are cast toothed gearing for rolling mills, hydraulic presses, bearers, eccentric straps, piston rings, &c. It is also specially adapted to the production of works of art and decoration. The ease of casting, the good colour, and its resistance to oxidation, are special qualities which adapt it to these purposes.

M. JANSSEN'S AERIAL EXPEDITION.

M. Janssen has furnished to the Academy a report of the aërial voyage which he undertook on the 2nd of December, 1870, to join the expedition to Algeria for observing the eclipse of the sun on the 22nd of December. The learned astronomer, wishing to pass the lines of the Prussians without soliciting permission of the enemy, decided to take his route through the air. In the absence of any experienced aëronauts, he himself undertook the command of the Volta, and quitted Paris on the 2nd of December at 6 a.m. from the Orleans station, accompanied by a marine named Chapelain. The Volta had 2000 cubic metres capacity, and, although hurriedly made, offered sufficient guarantees of stability and strength. It carried an equatorial parachute formed of a band of stuff 3 ft. wide, running round the centre of the balloon fixed on the upper side, and bound on the lower side by cords to the lower part of the balloon. Inflated with ordinary gas, the Volta had a rising force of 3080 lb., divided thus:

	lb.
Weight of the balloon complete	1144
Instruments	352
Two aëronauts	330
Ballast	1254
	3080

The instruments were reduced to their essential parts, and were to be completed at some large town on the route. These delicate pieces of mechanism were carefully packed in boxes arranged so as to resist violent shocks. On departure the astronomer judged that he was taking a southerly course. Ballast was thrown out, so that the line of investment might be passed at a minimum height of 3000 ft. At 7.15 the barometer stood at 25 7/12 in., and the thermometer at 30.20 degrees Fahr., and the direction was more decided towards the west. The balloon crossed the Eure to the north of Chartres. At 7.55 the sun rose, the air cooled rapidly, and the thermometer fell to 19.40 degrees. The balloon fell rapidly; ballast was thrown out. M. Janssen explains the apparent contradiction of the falling temperature and the rising sun by the fact that the first rays of heat dispersed the atmospheric vapours, and thus increased the radiation from the balloon. Up to 8 o'clock the effect of the solar radiation made itself felt more and more, the balloon rose, the thermometer fell. To ascertain the direction, M. Janssen made use of one of the points of the anchor suspended to the car. This point traced on the ground a line easy to follow. It was enough to align one side of the compass box with this direction to know the angle made by the route with the magnetic meridian. At 8.17 the direction was east, quarter south; the temperature was slightly raised, the weather magnificent. It was perfectly easy to make all observations, although the speed was 50 miles an hour. At 8.48 the balloon passed to the north of Mans. The town lay stretched out below so clearly visible in all its details that it would have been possible to take of it photographic pictures. At 9.45 the balloon attained an elevation of 6000 ft.; the barometer marked only 25 in. This elevation was due to the heating of the gas. At 10.40 it descended, the exterior air beginning to heat faster than the gas in the balloon. The thermometer indicated 33.80 degrees. The travellers passed over Château Gontier, whence a confused noise of acclamations was perfectly audible.

At 11.15, the astronomer saw that they neared the sea: it was necessary to descend without losing an instant. The valve was opened, and the barometer rose from 23 4/12 to 27 5/6 in.; it was a vertical fall of 4500 ft. The valve was closed, and ballast was cast out, to reduce the velocity of the descent. The fall thus checked, the balloon rose a little, and a height of 1200 or 1500 ft. was maintained. Again, the descent was accomplished to within 600 ft. There remained the final fall, always difficult and dangerous, but which, in this instance, promised to be accomplished under favourable conditions. Opening the valve, M. Janssen caused the balloon to descend, and a sack of ballast being thrown out, a height of 150 ft. was preserved. The guide rope was then cast over—a long heavy cord of 600 ft.—which, by its trailing along the ground, served as a brake. As soon as this rope struck the ground, it produced an ascensional undulation, followed by a soft and very oblique descent. Suddenly they neared a church steeple, which they cleared with a bound by throwing out a bag of ballast. The balloon then followed across land intersected with hedges. The marine threw the anchor and opened the valve, but the anchor broke, and after an instant, the balloon gathered speed, breaking through hedges and trees. At last the speed decreased, thanks to the friction of the

guide rope, which was seized by the peasants, and the adventurous travellers landed safely with all their instruments near St. Nazaire.

M. Jansen continued his scientific journey without further trouble. The voyage of the Volta proves the possibility of transporting by the aërial route heavy and delicate instruments. It is, moreover, especially interesting from the point of view of the physical atmospheric question. The study of this question will prove of much value in aërostatic observations.

THE LOSS OF H.M.S. CAPTAIN.

TO THE EDITOR OF ENGINEERING.

SIR,—A grievous error was made in calculating the stability of the Captain. So says Mr. Ruthven in his letter inserted in your impression of the 18th ultimo. If this were true naval architects would no doubt feel grateful to that gentleman for pointing out the *error*; but if false a far more grievous error has been made in publishing so authoritatively that which will tend to diminish unjustly in the public in general, and the navy in particular, the confidence they should feel in the men in whose hands the safety of our ships and the lives of our seamen are to so great an extent placed.

Had he pondered a little while longer he would perhaps have seen that he could not place 80 tons on the upper deck of a ship without altering the position of her centre of gravity, increasing her displacement, and reducing her stability.

Would it surprise him to learn that the 1600 foot-tons he speaks of may involve a weight sufficient to sink the ship?

Admit that a weight of 80 tons at a horizontal distance of 20 ft. would incline the ship 6½°, and suppose circumstances had prevented the distance from being more than 10 ft., the weight required to produce the same moment 1600 (foot-tons) would be 160 tons; and supposing the distance had been one foot the weight required would be 1600 tons, and if it were limited to 6 in. it would be 3200 tons, which would be more than sufficient to absorb all the surplus buoyancy in the ship, and to bring her wholly under water.

In the correct curve given by Mr. Barnes the ordinate to the curve at any angle is in length equal to the distance from the centre of gravity at which a force equal to the weight of the ship tends to right her when she is inclined to that angle.

I am, Sir, your obedient Servant,

G. E.

Portsmouth, September 5, 1871.

COOPERS HILL COLLEGE.

TO THE EDITOR OF ENGINEERING.

SIR,—In the "further papers relating to the Indian Civil Engineering College," presented to Parliament 23rd March, 1871, will be found, page 30, paragraph 39, the following:

> "39. Civil engineers appointed to the department from the new Civil Engineering College enter as assistants, second grade. They will either be placed at the disposal of the Government of India, and will be posted on arrival to one of the provinces under the administration of that Government, or else they will be sent, in the first instance, to Madras or Bombay, in which case they will not be liable to transfer from those provinces."

The young men at present in the college and others intending to go in may judge how far faith will be kept with them by the Government, by being informed, through your columns, that civil engineers, under solemn signed and sealed covenants, who went out to serve in a particular province, have lately received notice from the Government in India, that, unless they consent to go to other parts of India, their appointments will be cancelled, and they will be cast upon the world and deprived of their promised benefits of the uncovenanted service rules of pension to which they are entitled.

It is right also that the Coopers Hill students should know that it is reported—I have reason to know with some truth—that, at a very recent date, a R. E. officer of Public Works wrote to the head of the department (brother military officers) and got himself removed owing to his objection to act under a superintending civil engineer. The students at Coopers Hill College may rest assured, unless a radical change is made before they go out, they, like other civil engineers, will be looked upon by the Royal Engineers as only "professional pariahs."

Unless the engineering journals in this country will look into the claims of the civil engineers in India and endeavour by their advocacy to obtain common justice for them, I feel certain the present serious and well grounded dissatisfaction, existing in the great civil body of the Public Works Department in that country, will ripen into a great imperial disaster.

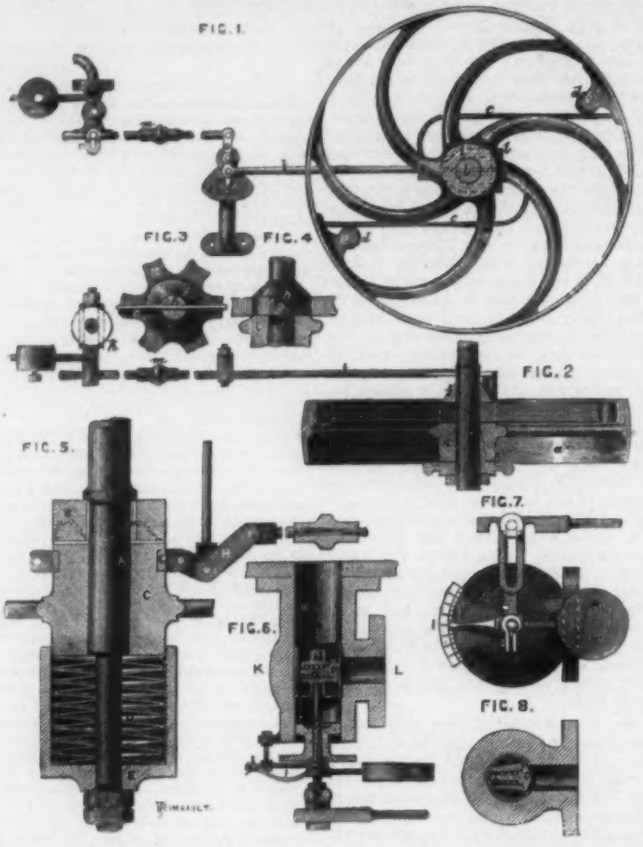
I am, Sir, your obedient Servant,

London, September 4, 1871. E.

PERUVIAN RAILWAYS.—A large party of visitors comprising some of the most distinguished inhabitants of Lima, recently inspected the progress made by Mr. Meiggs in the construction of a railway from Callao to the Arroyo pass in the Andes. The line already extends some 43 miles above Lima, reaching the foot chain of the Cordillera, having attained a height of nearly 7000 ft.

PETROLEUM.—The petroleum wells in the original oil districts of Pennsylvania which seven years since were drilled on the celebrated Buchanon Farm, after furnishing all the supply they were supposed to be capable of yielding, were abandoned as worthless. These wells and several others in the Oil Creek neighbourhood had recently been cleaned out and a supply of petroleum ranging from 8 barrels to 30 barrels per day has been obtained. The starting of these old wells proves, it is argued, the theory that crude petroleum is constantly forming in the bowels of the earth.

GAUTREAU'S DYNAMETRICAL GOVERNOR.



WE illustrate, above, an arrangement of "dynametrical governor" designed, and patented in this country, by M. Jacques Théophile Gautreau, of Paris, and which is intended for use either as a dynamometer, or as a governor for regulating the supply of steam to an engine according to the amount of work that engine is actually performing. The construction of the apparatus can be best explained by reference to the engravings which we annex. In the arrangement shown in Figs. 1, 2, and 3, the driving wheel, *a*, is loose on the shaft, *b*, and rotatory motion is transmitted to it by means of a spring, *c*, which is formed of a blade of steel, and passes through the shaft, *b*, to which it is thus firmly secured, the curved ends of this spring acting on rollers, *d*, which are carried in bearings, *e*, cast in one with the pulley, *a*. The angular displacement which may thus be produced between the wheel, *a*, and the shaft, *b*, is transmitted to the throttle valve by a boss, *f*, fitted so as to move with but little friction along the shaft, *b*, and recessed in order to admit of the spring, *c*, passing through it, by which means it is caused to turn with the shaft, *a*, whilst at the same time it is free to move longitudinally along it. The boss, *f*, has formed on its periphery a helicoidal groove, *g*, in which a pin, *h*, works, which pin is carried by a projection cast in one with the boss, *i*, of the pulley, *a*. By this means any displacement of the pulley in relation to the boss, *f*, produces a corresponding linear displacement of the latter in the direction of the centre of the shaft, *b*. This linear displacement is in its turn transmitted to the rod, *j*, which actuates the steam inlet cock, *k*; for this purpose the boss, *f*, is provided with a conical surface on which an inclined abutting piece, *l*, slides, which is maintained between the bifurcated extremities of the rod, *j*.

In order to facilitate the regulating of the engine the rod, *j*, is provided with a screwed socket, *m*, which admits of the length of the rod being varied, and the original position of the cock or sector, *k*, being determined, the plug, *n*, of the cock is also furnished with a slot in which a button on the end of the rod, *j*, is capable of moving, by which means the opening of the cock for a given amount of linear displacement of the rod, *j*, may be varied at will.

In order to utilise the apparatus as a dynamometer it is simply necessary to interpose on the rod, *j*, a lever, *o*, provided with a hand or pointer, *p*, to move over a divided dial or quadrant, *q*. By this means the amount of motive power transmitted by the engine may at each instant be ascertained, and the relative proportions of the two arms of the lever, *o*, co-operate to determine the admission of steam to the engine in proportion to the tractive strains which the driving belt has to overcome.

Figs. 4, 5, 6, and 7 illustrate another type of governor which differs from that herein before described, in that the blade springs are replaced by disc springs, and that the rectilinear displacement which has to act on the valves is obtained on the driving wheel itself. This arrangement therefore is not applicable where gearing is the medium used for transmitting power, but simply when a belt and pulleys are employed. B is a collar which is fast on the shaft, A, and is provided with a series of teeth or inclined planes corresponding to similar inclined planes cut on the boss, C, of the driving wheel; the boss, C, which is loose on the shaft, A, is maintained against the collar, B, by a series of disc springs, D, disposed around the shaft, and enclosed in a box, E, the position of which is adjusted by means of the nuts, F, which determine the degree of tightness of the springs, D. The effect of this arrangement is that when any variation takes place in the strain transmitted by the belt the springs, D, bend, and the oblique teeth of the boss, C, engage more or less with those on the collar, B, the position of the driving wheel on its shaft is thus changed, and this variation is transmitted to the valves by means of the collar, G, and the cranked arm, H. In this type of governor, as in the preceding one, an indicating hand or pointer, I, moving over a dial or quadrant, J, is employed for the purpose of indicating at each instant the amount of motive power transmitted by the engine, and a counterweight, K, is provided, which has a constant tendency to bring back the driving wheel to the required position when a change in the deflection of the springs, D, takes place.

The description of valve which it is proposed to employ with this system of governor, is shown in Figs. 5, 6, and 7. It is composed of a brass box, L, fixed in the interior of the steam pipe, M, in which moves a piece, N, actuated by the rod, O, which carries the indicating hand or pointer, I, and the counterweight, K, and actuates a cylindrical closer, P, intended to more or less cover the aperture through which the steam enters the slide valves. In order to compensate for the wear which may take place during the working, the cylindrical closer, P, is constantly maintained against the inlet aperture by means of a helical spring, Q, which is disposed in the interior of the piece, N.

THE BLACKFRIARS AND BLACKHEATH TRAMWAYS.—The tramway lines between Blackfriars Bridge, East Greenwich, and Blackheath Hill, were opened throughout on Wednesday The first car left East Greenwich at 8 a.m., and the cars will continue to leave every ten minutes throughout the day until 10.10 p.m. On Sundays the cars will commence running at 9 a.m., and continue until 9.40 p.m. From Blackheath Hill the first car left (Wednesday) at 8.8, and the cars will continue to start every twenty minutes until 12 p.m. Passengers from Blackheath Hill change cars at Deptford Bridge Junction. The first car left Blackfriars Bridge at 9.4, and the cars will continue to run to Greenwich and Blackheath every ten minutes throughout the day until 11.14 p.m. On Sundays the cars will commence running from Blackfriars at 10 a.m., and run every ten minutes until 10.44 p.m. The journey to Blackheath is performed in about forty minutes.

THE COAL-FIELDS OF STAFFORDSHIRE.

*The Geological Features of the South Staffordshire Coal-Field, in Special Reference to its Future Development.**

By Mr. HENRY JOHNSON, Mining Engineer, Dudley.

In commencing his paper the author remarked that it was well known that South Staffordshire was one of the oldest of the great mineral producing districts of Great Britain, for it was in the immediate vicinity of Dudley that Dud Dudley first demonstrated the practicability of smelting clay ironstone with coal; and though the discovery was of no benefit to him, posterity had acknowledged the debt which the iron trade owed to one of the early masters, whilst the district had ever been famous for the production of iron. The South Staffordshire coal-field in its virgin state was remarkably rich in coal, ironstone, and limestone, and, from the position in which they lay "and cropped," they could not well escape observation. In concentration of wealth no part of Great Britain had presented such striking characteristics. Rich seams existed but a short distance from the surface, and the various minerals lay so close together that ironstone and coal were worked by one operation. The most valuable seam was the famous "thick," or ten yard coal, representing a deposit of carbonaceous matter, the equal of which was not to be found in any other coal-field in Great Britain. The enormous bed might be said to consist of numerous minor beds, with but little foreign matter intervening, except in the south, where there was a large clayey deposit separating the beds. It was remarked, however, that the necessities of the local and other ironmasters, and the demand for domestic consumption, had led to a continuous extraction, and that, notwithstanding the enormous supply of minerals originally existing in the locality, it must be admitted that the older portion of the Black Country was nearly worked out.

Under these circumstances it was of vital importance to the district to ascertain how long the deposits were likely to last, and what were the prospects of following the coal measures underneath the red rocks which surrounded the coal-field. The object of the paper he had the honour to read was to give a sketch of the geological features of the district in special reference to the future extension of its mineral resources. The composition of the rocks were igneous and aqueous; and of the latter, in ascending order, there were: The silurian, consisting of Wenlock and Ludlow series; 2, coal measures proper; 3, permian; 4, new red sandstone; 5, drift deposits. The former comprised masses of columnar basalt, interbedded traps, and decomposed intensive igneous rocks of various kinds.

The South Staffordshire coal measures repose throughout the district upon a floor of silurian strata, which were brought to the surface in some places, and had been proved in deep sinkings below the coal in the centre of the district. Between Dudley and Wolverhampton there are a number of eminences, for the most part anticlinals of upper silurian strata, the strike of the beds being nearly north and south, in evidence of the lateral disturbance of the beds by faults. Dudley Castle, Wren's Nest, and Thurst Hills were composed of Wenlock limestone and shale, the former in two bands, and used in blast furnaces. These silurian strata occupied a nearly horizontal position underneath the central part of the coal-field, but gradually rose to the east, and in the neighbourhood of Walsall they "cropped" out. A few miles east of Walsall there were indications of lower members of silurian series than those mentioned. The Hay Head, or barr limestone, was regarded as the equivalent of the Woolhope limestone of Herefordshire; and at Barr, and near Hay Head, a yellowish sandstone occurred, and that evidently corresponded with the Llandover sandstone. Further west, on the side of the coal-field, however, no silurian beds newer than the Wenlock series had been found. At Sedgley Beacon, about 3 miles south of Wolverhampton, the Wenlock beds were overlaid by the limestone and shales of the Ludlow rocks, and a small patch of the same formation was brought to the surface at the Hays, near Stourbridge. It was then evident that the coal measures rested upon the upper silurian deposit, though not conformably. There was an indication of a great break in the geological series, for there was no trace of the different members of the old red sandstone, mountain limestone, and Yoredale series, of millstone grit, all of which ought to intervene between the silurian and the coal measures proper if the series were complete. It was assumed that from the close of the silurian period to the commencement of the formation of the coal measures proper a tract of silurian country stretched across the central part of England, as it now is from east to west, and formed a large island in the early seas. Thus the causes which successfully operated in laying down the old red sandstone, mountain limestone, and millstone grit, had no effect on the dry land of that time. Later on, however, the island was depressed, and the true coal measures deposited on it, and there was ample evidence to prove that the silurian measures had undergone much abrading action, and had in many places been partially removed previous to the deposition of the coal measures upon them.

The true coal measures attained in some parts of the field a thickness of about 1000 ft. and the area of the coal-field was from 110 to 120 square miles, extending from Cradley Park Colliery to the Brereton Colliery, near Rugeley, and from Bullock's Farm, West Bromwich, to Thinley. The various seams of coal and ironstone were not persistent, and very frequently changes took place within a comparatively short space, and thus it was not easy to correlate the beds either in those existing in other coal-fields or in distant parts of the same field. In considering how far evidence of this kind might be made available in tracing a connexion between the South Staffordshire and adjoining coal-fields, it was advisable that the foregoing fact should be remembered. The general character of the measures in the central, south, and north portions of the field were best illustrated by the sections given in the memoirs of the Geographical Society. They showed a total thickness of 90 ft. From reliable information obtained by him (the reader) a few years ago, the average thickness of the thick coal worked up to that time was about 7½ yards thick of clean coal; but at the Clay Cross open work, near Coseley, it measures 12 yards 2 ft. thick. Following the measures towards the north-east, the thick coal "cropped" out near Bilston and Wednesbury, and beyond this point up to the Bentley Trough fault the coal and ironstone underlying the thick coal increases in thickness and value; and to the north of Bentley fault were the Cannock Chase measures, which were supposed to be a portion of thick coal deposited in varying thicknesses. In the southern portion of the field, from Park Head to the south, there was a gradual thickening of shales and sandstones, until it came to little better than a bed of mud under the permians, at Hagley, and south of Hales Owen. It was very difficult to account for the reduction of the finest bed of coal in the world to one that was valueless in the short distance of 3 miles.

The author divided the South Staffordshire coal-field into four districts, each having very singular and apparently fortuitous geological conditions:—1, South central, where the thick coal—fine and very thick—is free from partings, with under measures thin and poor in quality; 2, north central, where the thick coal was wanting altogether, the under measures of both coal and ironstone being of fine quality, and nearly double the thickness as compared with the places where the thick coal exists; 3, extreme north, where the thick coal is absent as one bed, and the ironstones absent too, but where there were seams of coal of fine quality and great thickness; 4, the extreme south, where the thick coal is split up into numerous and separate beds of almost worthless character, together with a lack of ironstone. In the latter, however, there were two beds of pure fire-clay, counterbalancing the loss of the thick coal of fine quality. To attempt to account for the seeming incongruities would take too long, but the subject was one of deep interest to the inquiring geologist.

Over the whole field the measures had been disturbed by "faults," among the most important being the great boundary faults at Russell's Hall, a down throw; at Dudley Port, down throw; at Brierley Hill, down throw; at Ball's Hill, up throw; and at Bentley, down throw. Igneous rocks are found in various parts of the field, the most important mass being that of the Rowley Hills, south of Dudley, whilst there were also Barrow Hill, north-west of Dudley, and Powke Hill. Intensive veins of trap rock were also numerous, and the coal had been altered by the contact. These rocks were supposed to belong to the carboniferous period, but they might be younger. Recent mining operations had thrown much light upon the basalt and the coal; and it had been clearly shown that the basalt was but a comparatively thin covering over the coal measures which lay in regular order beneath this rock, which appeared to have been forced upwards through a small opening or openings, and have spread itself over what was at that period dry land or the bottom of a shallow sea. Thirty or forty years ago it was the general opinion that the coal could not be found under the hills, or within a long distance; but experience had shown that some of the best coal in South Staffordshire had been discovered beneath them. The most remarkable event in the discovery was that in the sinking of Mr. Minton's new pits, a distance of 275 yards, no basalt was met with, although it was *in situ* high and columnar, within about 50 yards of the pit tops. The Earl of Dudley was also raising large quantities of coal from under the hills, although at Oakham one of the pits was much disturbed by trap. Several square miles had been added to the area of the field by the discovery.

Mr. Johnson next described the great boundary faults, and argued that they were not supposed to cut off the coal measures, but simply to lower them a greater depth from the surface. Upon such an assumption there was reason to believe that coal would eventually be found on three, if not on all sides of the existing field, by penetrating the rocks; but it was of course, impossible to say at what depth the coal would be found, or successfully worked.

One of the earliest successful attempts to discover coal beneath the permians and new red sandstone in England was made by the Earl of Dartmouth at the Heath Colliery, West Bromwich, in 1832. The thick coal of a large area was there discovered after years of difficult sinking through water-bearing works. This coal was worked to what was believed to be a downthrow, but lately the belief that coal would be found nearer Birmingham gained ground, and twelve months ago a company called the Sandwell Park Colliery Company was formed to test the ground about a mile and a quarter west of the colliery alluded to. If the coal was discovered it would not only be a great acquisition to the wealth and property of the South Staffordshire coal-field, but it would not be unreasonable to predict a connexion between the coal-fields of Warwickshire and South Staffordshire. The sinking at Sandwell had proceeded to a depth of 70 yards with perfect freedom from running sand, and very little water. Mr. Johnson here described the sinking operations, which have been described from time to time in these columns. Besides this sinking in the Permian there had been several lateral headways driven from the coal measures into the red rocks, on the downthrow side of the western boundary fault, by the Earl of Dudley and others, but without a discovery of the amount of downthrow. The only true test for that side of the coal-field was to sink a shaft in some favourable spot between the Shropshire coal-fields and the South Staffordshire; and it was to be regretted that the vast unexplored region lying between the two coal-fields did not possess sufficient landed and mining interest to put the suggestion to a practical test.

A few years ago two important trial sinkings were commenced in the south end of the coal-field. The first was at Wassel Grove estate, near Hagley; but more than one party grew tired of it, and it was not until Messrs. Crampton took up the matter that it was decided. At a depth of 165 yards a 3½ ft. seam of inferior quality associated with about 25 ft. of thin coals and bats which clearly represented the thick seam, but was of no commercial value. The pit was sunk to 202 yards, when the upper Ludlow beds were pierced, and this fact showed that the finding of coal was hopeless. The other important sinking was a few years ago commenced at Manor Farm, near Halesowen, by John B. Dawes. This sinking, after passing through an extra thickness of upper coal measures reached a bed of coal of about 3 ft. 6 in. in thickness, at a depth of 306 yards, and very extensive lateral explorations were being carried on with the hope of discovering the thick coal.

In this sinking were pierced at a depth of 420 yards the upper Ludlow limestone beds. Recently, the West Cannock Colliery Company had discovered the shallow and deep coals of Cannock Chase, at a depth to the deep coal of 307 yards. The sinking has gone through what the Ordnance map was pleased to call "Quartzose gravel, unconsolidated conglomerates, and the new sandstone," at a point beyond the predicted run of the great western boundary, and then speculation was rife as to the exact position of that fault in the north-west portion of the coal-field. A trial has recently been attempted at Huntingdon, but the affair had come to a dead lock. In all probability the most signal piece of good fortune which has befallen explorers of the confines of this coal-field is at Aldridge, where the proprietors of the Coppice Colliery, after working a series of upper coals and ironstones not very successfully, concluded to abandon the place; but, through the exertions of Mr. Lindop, the mining engineer of the company, a test of the ground was made, and at a depth of 450 yards the shallow and deep coal had been found sufficiently near to work together. Mr. Johnson said it would be difficult to indicate the importance of the discovery, as it would go far to connect the Aldridge district, not only with the Cannock Chase, but is strong evidence in support of a connexion existing between the South Staffordshire and Warwickshire coalfields. The reader then referred to the ease with which the correlation of the South Staffordshire and Shropshire coals and ironstones could be made, and referred to the report of the Coal Commission just issued, "On the Probability of Finding Coal under the Permian and New Red Sandstone," and pointed out the fact of their having expressed a strong opinion in favour of the probabilities of coal being ultimately found between the two coal-fields. The report, the author said, was equally favourable as to there being coal found ultimately between South Staffordshire coal-field and Warwickshire. The author estimated these two unexplored regions at six times the area of the South Staffordshire coal-field, and he hoped the country may yet have to rejoice in the successful discovery of coal in these immense tracts of country referred to, which would enable South Staffordshire to hold her prestige among the iron manufacturing centres of the kingdom, and the effort now made by the Iron and Steel Institute to further the object would not have been without its good results.

* Abstract of paper read before the Iron and Steel Institute at Dudley.

STEAM BOILER LEGISLATION.*

By LAVINGTON E. FLETCHER, C.E.

ALTHOUGH the Committee of the British Association "appointed to consider and report on the various plans proposed for legislating on the subject of Steam Boiler Explosions, with a view to their prevention" are compelled, from the reasons stated in their *ad interim* report, to postpone the consideration of the measures recently recommended by the Parliamentary Committee, yet it is thought that it would be well to take advantage of the present opportunity to discuss those measures, and therefore this paper is presented to the Mechanical Section.

The report of the Parliamentary Committee is briefly as follows:

The Parliamentary Committee had it laid before them in evidence that there were not less than 100,000 steam boilers in the country, and that from these there sprung on an average 50 explosions per annum, killing 75 persons and injuring many others, from which it appeared that one boiler in every 2000 explodes annually. It was further stated that steam boilers were in many instances situated in much frequented parts of towns and cities, under pavements in thronged thoroughfares, in the lower storeys of houses, and in the midst of crowded dwellings. That such boilers, notwithstanding their dangerous position, were often faulty in construction, and frequently so set that inspection was impossible without removing the brick-work setting, while they lacked proper gauges and necessary fittings.

The Parliamentary Committee arrived at the conclusion that the majority of explosions arise from negligence, either as regards original construction, inattention of users or their servants, neglect of proper repairs, and absence of proper and necessary fittings, while they further considered that the several voluntary associations, formed with a view of securing the periodical inspection of boilers, had been useful in preventing explosions.

The Parliamentary Committee recommend not that inspection should be enforced by law in order to render its adoption universal, but that it be enacted that every steam user should be held responsible for the efficiency of his boiler, the onus of proof of efficiency in the event of explosion being thrown upon him, and further that in case of a servant being injured by the explosion of his master's boiler, that it should be no defence to plead that the damage arose from the neglect of a fellow-servant. The committee further recommend that coroners in conducting their inquiries on steam boiler explosions should be assisted by a competent engineer appointed by the Board of Trade, and that these inquiries should not as at present be limited to fatal explosions, but be extended to all others, while reports on the result of each investigation should be forwarded to the Secretary of State for the Home Department, and also be annually presented to Parliament.

The effect of these recommendations, if carried into practice, would be to render the steam user readily amenable to an action for damages, so that those who suffered from

* Paper read before Section G of the British Association.

the consequences of an explosion would become the prosecutors. Thus the Parliamentary Committee do not recommend direct prevention by the enforcement of inspection, but indirect prevention by penalty.

It will be seen from the foregoing that the evidence laid before the Parliamentary Committee endorses the statements made in the reports to the British Association, on the number and fatality of explosions,* while the committee speaks favourably of the effect of periodical inspection for the prevention of explosions.

Also, the opinion of the Parliamentary Committee with regard to the cause of explosions, corroborates the views already expressed in the reports to the British Association on this subject, viz.: that explosions are not mysterious, inexplicable, or unavoidable; that they do not happen by caprice alike to the careful and the careless; that, as a rule, boilers burst simply because they are bad—bad either from original malconstruction, or from the condition into which they have been allowed to fall; and that explosions might be prevented by the exercise of common knowledge and common care.† It is satisfactory to have this principle endorsed by the Parliamentary Committee. Explosions have too long been considered accidental, and to be shrouded in mystery, and this view has seriously arrested progress. Where mystery begins, prevention ends. It is now trusted that it will be thoroughly recognised that explosions are not the result of the freaks of fate, but of commercial greed, and this fundamental principle being firmly established, it cannot be doubted that these catastrophes will ultimately, in one way or another, be prevented. Thus it is thought that a most important step has been taken which is a considerable matter for congratulation.

It is also satisfactory that the Parliamentary Committee has recommended that coroners, when conducting inquiries consequent on steam boiler explosions, should be assisted by scientific assessors, a practice which was strongly urged in the report laid before the British Association at the Exeter meeting.‡ It may, however, be open to question whether it would be better that the engineer, as the Parliamentary Committee recommend, should be appointed by the Board of Trade, or that the coroner should be empowered to appoint two competent independent engineers to investigate the cause of the explosion, and report thereon, as suggested in the report referred to. But whichever course be adopted, if competent reports be insured, a public service will be rendered.

Not only, however, should the "result" of each investigation be reported to Parliament, but also all the evidence of an engineering character, accompanied with suitable drawings to illustrate the cause of the explosion, so that all the information to be derived from these sad catastrophes might be disseminated as widely as possible.

Further, it is presumed that the reports on explosions which occur in Scotland, where coroner's inquests are not held, will nevertheless be presented to Parliament.

It is most important that the Bill embodying the recommendations of the Parliamentary Committee should provide for other engineers having an opportunity of making an examination of the fragments of the exploded boiler, as well as those appointed by the Board of Trade, otherwise the intervention of the Board of Trade will have a seriously harassing effect. The system practised in Scotland, where the Procurator-Fiscal appoints an engineer to report to him officially, is found very much to impede other investigations, and engineers who have gone all the way from England to visit the scene of explosions in Scotland with the view of giving the facts to the public have been forbidden access to the scene of the catastrophe, so that the Procurator-Fiscal receives information which he does not circulate, while he withholds the opportunity of gaining information from those who would circulate it, and thus he stands in the way of the public good. It is most important that care should be taken that investigations by Board of Trade officers do not have the same obstructive effect in England, and to this end there should be a special provision that the coroner be invested with a discretionary power to admit any suitable parties to make an investigation.

Passing over the consideration of details, it is certainly considered that the three following conclusions arrived at in the Parliamentary report, firstly, that as a rule explosions are not accidental but preventible; secondly, that on the occurrence of explosions a complete investigation of the cause of the catastrophe should be promoted by the appointment of a scientific assessor to assist the coroner; and, thirdly, that reports of each investigation should be presented to Parliament—these three conclusions, it is considered, form a foundation from which a superstructure will spring in course of time which must eradicate steam boiler explosions.

What the precise character of that superstructure should be, is a question on which opinions may differ. Some—among whom are the Parliamentary Committee as already explained—prefer a system of pains and penalties to be inflicted on the steam user in the event of his allowing his boiler to give rise to an explosion. Others prefer a system of direct prevention by the enforcement of inspection on the following general basis: They would recommend a national system of periodical inspection enforced but not administered by the Government, that administration being committed to the steam users themselves, with a due infusion of *ex officio* representatives of the public. For this purpose they propose that steam users should be aggregated into as many district corporations as might be found desirable, boards of control, empowered to carry out the inspections, and levy such rates upon the steam users as might be necessary for the conduct of the service, being appointed by the popular election of the steam users in each district, the different boards being affiliated by means of an annual conference in order to promote the harmonious working of the whole system. Its advocates consider that in this way a system of national inspection might be mildly but at the same time firmly administered, and that it would then not only prevent the majority of steam boiler explosions, but prove of great assistance to steam users in the management of their boilers. That it would be the means of disseminating much valuable information. That it would promote improvements. That it would raise the standard of boiler engineering, and prove a national gain.

The question of the relative merits of the two systems, the one, that of direct prevention by enforced inspection, the other, that of indirect prevention by the infliction of penalty, is one of a very complex character, and the more it is discussed, the better, and therefore the fullest expression of opinion is requested at this time.

A further topic for discussion on the present occasion is suggested, viz., whether it might not be well to fix a minimum sum to be exacted absolutely in the event of every explosion, that fixed sum, however, when inadequate to cover the damage done, not to limit the claim for compensation.

Several advantages it is thought would spring from the adoption of this course, both as regards compensation to those injured and the prevention of explosions.

It frequently happens on the occurrence of disastrous explosions that boiler owners are quite unable to compensate those who have been injured. Such was the case last year at Liverpool, where an explosion occurred at a small iron foundry, in October, killing four persons, laying the foundry in ruins, smashing in some of the surrounding dwelling-houses, and spreading a vast amount of devastation all round. The owners of the boiler, which had been picked up second hand, and was a little worn-out thing, were two working men, who but a short time before the explosion had been acting as journeymen. They were possessed of little or no capital, and were rendered penniless by the disaster. Another very similar case, though much more serious, occurred at Bingley, in June, 1869, where as many as 15 persons were killed, and 31 others severely injured by the explosion of a boiler at a bobbin turnery. In this case the user of the boiler was only a tenant, and, judging from the ruined appearance of the premises after the explosion, any attempt to gain compensation for the loss of 15 lives and 31 cases of serious personal injury would be absolutely futile. The plan of imposing a fixed minimum penalty would tend somewhat to meet this difficulty, as the surplus of one would correct the deficit of another, and in this way a compensation fund might be established for the benefit of the sufferers.

Further, this measure would have a good effect upon steam users, inasmuch as they would then incur a positive liability, which would act as a more definite stimulus than the vague apprehension of an action for damages, in which they might hope to get off. Also if this penalty were rendered absolute it would save a vast amount of litigation, and boiler owners would then see that it was as much to their interest to believe that explosions were preventible as that they were accidental, and such being the case they would soon find out the way to prevent them.*

This definite minimum penalty would also tend to meet the present tendency of boiler owners to seek to purchase indemnities from insurance companies in the event of explosions, rather than competent inspection to prevent these catastrophes, since if the penalty were made sufficiently high it would pay an insurance company as well to make inspections and prevent explosions, as to adopt comparatively little inspection, permit occasional if not frequent explosions, and pay compensation. As pointed out last year at Liverpool, the principle of steam boiler insurance by joint stock companies, does not, under the influence of competition, necessarily insure inspection, inasmuch as the number of explosions being one in 2000 boilers per annum, it follows that the net cost of insurance is only 1s. for every 100*l.*, which must evidently be inadequate for any description of inspection by way of prevention. Insurance therefore, as previously pointed out, is cheap, while adequate inspection is costly, so that inspection is opposed to dividend, for which joint stock companies are clearly established. Some corrective, therefore, is plainly necessary, and this it is thought would in some measure be found by the establishment of a fixed substantial penalty in the event of every explosion, irrespective of the amount of damage done. Also, the imposition of a penalty on every inspection association or insurance company failing to prevent the explosion of a boiler under their care, might have a most wholesome tendency, this penalty being equal and in addition to the one imposed on the owner, and, in like manner, devoted to the support of the compensation fund.†

In conclusion, although entire assent cannot be accorded to the Parliamentary report, yet it is most cordially wished that every success may attend the adoption of the measures recommended therein, and that they may result in preventing many explosions, and in diminishing the lamentable loss of life at present resulting from the constant recurrence of these catastrophes.

The Pacific Railroad.—The through shipments eastwards on the Pacific Railroad in the first six months of 1871 amounted to 10,624 tons. The value of the tea and wool passing over the road is returned at upwards of 4,000,000 dollars.

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* See *Transactions* of the British Association, Norwich meeting, 1868; Exeter meeting, 1869; and Liverpool meeting, 1870.

† See page 60. *Transactions* of the British Association at the Exeter meeting, 1869.

‡ See page 50. *Transactions* of the British Association at the Exeter meeting, 1869.

* Steam users, however, should be exempted from penalty in those cases of explosion resulting from the direct intention of some evil-disposed person, for which the user could not be held responsible, and which might be regarded as an act of conspiracy, intrigue, or plot.

† The exemption described above in favour of steam users should also apply under similar circumstances to inspection associations or insurance companies.

CIVIL ENGINEERS AND THE P.W.D.

To the Editor of Engineering.

Sir,—In your issue of the 12th of May last you notice in an article the recent Memorial of the Civil Engineers of the Public Works Department of India addressed to the Secretary of State, showing that they labour under disadvantages in regard to leave, pension, and position, and remark generally on the injustice of their classification.

To show how necessary this memorial to the Secretary of State is in regard to position, I would draw your attention, and that of the profession generally, to the Table of Rank and Precedence for India published in the *India Gazette* of the 6th inst. This Table was drawn up by the Indian Government about the time of the receipt of the original Memorial of the Civil Engineers to that Government, who as yet have vouchsafed no reply.

It will be seen how totally the Public Works officers as a body have been ignored in this Table, the whole of the lower superintending and executive grades being omitted, while junior grades of other departments have been fairly recognised.

The Table of Precedence as it now stands, only goes down to the rank of superintending engineers, 1st class. If by class is meant grade, then out of a body of 477 European civil engineers (exclusive of Madras and Bombay), 3 only have any recognised position. This omission of the lower grades of superintending engineers is supposed to be accidental, as formerly they were divided into two classes, but it is clear that one of the classes was intended to be excluded, which is the more remarkable, because 2nd grade telegraph superintendents are included in the Table.

As elsewhere, so in India, a man's income chiefly gives him his position in society. It may not be out of place, then, to show in a tabular comparative form the pay of those officers included in the Precedence Table with those of the Public Works Department unrecognised:

Rank in precedence table.	Recognised officers.	Pay per month.	Unrecognised officers.	Pay per month.
		Rs.		Rs.
Third class	*Financial Department.*		*Public Works Department.*	
	1st grade officers	1500 to 2000	2nd grade Superintending engineers	1350
	2nd " "	1000 to 1500	3rd ditto	1100
	Education Department.			
	1st grade officers	1500		
	2nd " "	1000 to 1250		
	Telegraph Department.			
	1st grade Superintendents	1050 to 1500		
	Public Works Department			
	1st class Superintending engineers	1500		
Fourth class	*Financial Department.*		*Public Works Department.*	
	3rd grade officers	800 to 1000	1st grade Executive engineers	950
	Education Department.			
	3rd grade officers	750 to 1000	2nd ditto	800
	4th " "	500 to 750	3rd ditto	650
			4th ditto	550
	Telegraph Department.			
	2nd grade Superintendents	800 to 1000		

From the above statement no one can fail to see how the Government of India esteems their Public Works officers. They have recognised officers of the Education Department on 500 rupees a month (whose duties are merely to teach native boys) above all their executive and the majority of their superintending engineers, who are for the most part men of long experience, drawing more than double the education officer's pay.

On what principles the Precedence Table has been framed it is difficult to say, but it is a matter in which the engineering profession generally is interested, and one among several other things that ought to be made known in England, especially to the young men who contemplate going to Coopers Hill College, or otherwise preparing themselves for the Public Works Service of India, that they may be aware of the position in which they will be placed in this country.

The present civil engineers of the Public Works Department are unfortunate in having no men yet of their own cloth at the head of affairs to bring forward their claims and rights. They now are obliged to "grin and bear it," but they believe that Government must before long do away with the anomalies under which they suffer. They feel, however, that the rectification of these anomalies must in a great measure be brought about by pressure at home, and for this reason your aid is requested in giving this and the other subjects mentioned in their late Memorial full publicity and ventilation.

I am, Sir, yours truly,
India, July 22, 1871. C.E., P.W.D.

The Tiber.—Commissioners who have for some months been at work in devising methods for the improvement of the Tiber in its passage through Rome and the adjacent country, have, it is stated, decided upon a plan which will reduce the level of the stream 6½ ft. The general plan of improvement consists in the removal of obstacles to the current in the shape of mills, the destruction of the Ponte Rotto, and of such portions of the other bridges as can be safely taken away, and the partial or entire levelling of the fortifications round the Castle of St. Angelo. These plans all indicate a tendency to a more energetic administration of Italian affairs.

THE "WATERSTAAT" OF HOLLAND.

No. V.

(*Concluded from page 133.*)

THE historical period of the Waterstaat from 1830 to 1849 commenced under circumstances far from favourable to the general interests of the corps of that department. A constant difference of opinion concerning, and even opposition to, the execution of the decrees of 1819 and 1822, discontent at the transfer of the control to the Amortisation Syndicate, and the non-appointment of an inspector-general, by which the existence of the staff was imperilled, were not calculated to promote the unity in plan and execution aimed at by Brunings. His advice was neglected, and the warning voice of the River Committee of 1825 had lost its power. The calamities of 1820 were not quite effaced from the memory, but the good fortune the country had since that time enjoyed, in not being harassed from the side of the rivers, caused the administration of the Waterstaat to be overlooked. Such was the case when the Revolution of 1830 separated the Belgian provinces from the United Netherlands. Many engineers, Belgians by birth, preferred staying in their own country; others, among whom were J. H. Ferrand, M. H. Conrad, and L. J. A. van der Kun, returned. A new organisation of the Waterstaat was the necessary consequence. The uncertain state of the affairs of the country admitted only of provisional arrangements. It was therefore agreed that, at first, the corps should be composed of 1 inspector-general, 2 inspectors, 12 engineers-in-chief, 30 engineers, 8 Aspiranten, and 3 Conducteurs in regular service; while the appointment of surveyors should be annual. The inspectors were D. Mentz and A. Goekoop. Divers matters affecting the Waterstaat continued to be regulated by royal decrees. One of them deserving special notice is that of the 28th of June, 1831, concerning the navigation of the Rhine, in consequence of an agreement come to at Mayence, by the littoral states, on the 31st of March, 1831. Meanwhile, by another, 13th July, 1831, the administration of the Waterstaat was again transferred to the Home Office, where it has ever since remained. Shortly after, the office of administrator was abolished, and in the department a referendary was appointed at the head of the Waterstaat; besides, the minister was to be assisted by four advisers, not belonging to the department, who were to inform him about all matters which might be committed to them. Neither did this arrangement, during the absence of an inspector-general, contribute greatly to the so much desired unity in the Waterstaat, which the old Administrator Ewyk, who had been appointed referendary, perceiving, he solicited employment as head of the department as well. His request was granted. Various matters were still ordered by royal decrees; some of which were doubtless good, though the regulation by them was somewhat too one-sided. Besides these royal decrees, and of not less importance, was the law of the 28th of April, 1835, by which that of 1810 was superseded.

Now the important question of railways in the Netherlands was brought forward, and the Dutch Railway Company (Hollandsche Yzeren Spoorweg Maatschappy), formed in consequence of a royal decree of the 1st of June, 1836, was to open the way for private enterprise by the constructing of a railway, by way of trial, from Amsterdam to Haarlem, which, by further concession, obtained on the 22nd of June, 1840, was extended to Rotterdam. However, before the concession for the Amsterdam and Haarlem Railway had been given, a plan for another railway from Amsterdam to Arnhem, to be extended to the Prussian frontiers, and there join with the German railways, had been drawn up in the general service of the Waterstaat, by B. H. Goudrian, Bake, and Van der Kun. For the execution of this railway the king appealed to the merchants of Amsterdam, but without success. Passing over the discussion to which the subject gave rise, we will simply notice that a Bill for the construction of this railway, but also including the proposition for the drainage of the lake of Haarlem, was rejected by the Second Chamber of the States-General (Session 1837-38), by 46 against 2 votes in its favour. Nevertheless, on the 30th of April, 1838, by a royal decree, the construction of the railway from Amsterdam was authorised, as well as the contracting of a loan of 9,000,000 florins, at 4½ per cent., for that purpose, the payment being guaranteed out of the royal purse. The next measure important to the Waterstaat was that by which the draining of the Lake of Haarlem was ordered (22nd of March, 1839) for the estimated cost of which a loan was voted of 8,000,000 florins at 5 per cent. The necessity for this undertaking had been shown by a statement of the cost of protecting the banks between 1766 and 1839, which amounted to 3,260,660 florins (more than 261,000*l.*). Before the diking and draining proper could be begun with, it was necessary to widen the canal to Katwyk, as well as the sluices in connexion with it. The first stone of the sluice had been laid on the 22nd of July, 1805, by M. van Heteren Gevers, then a page to King Louis, that of the widened sluice by a son of that gentleman on the 22nd of July, 1843. The former works were conducted by F. W. Conrad, sen., A. Blanken, and S. Kros; the execution of the latter was confided to F. W. Conrad's son, and it was for his treatise on the Katwyk Canal translated into English by Mr. C. Manby, and read before the Institution of Civil Engineers, on the 21st of June, 1842, that the Telford medal was awarded and Conrad elected a member of that body in 1843. However conducive these works may have been to the public welfare, some of the measures taken by the Government were by no means encouraging to the corps of the engineers of the Waterstaat. Though, fortunately, by a law of 27th December, 1840, the Amortisation Syndicate was abolished, and by a royal decree (22nd of March, 1841) the material control of the highways, canals, &c., was to be transferred to the Home Office. Further, on the 29th of May, 1841, a law concerning expropriations for the public benefit was passed, and on the 9th of October following another, by which all judicial power was taken away from Dykemotes, Polder Boards, &c. The former was intended to remove the inconvenience and hindrance to the progress of great public works caused by the defective law on the subject of expropriation, but which were comparatively unfelt till the construction of the two great railways, and the draining of the Haarlem Lake were resolved on. It proved ineffectual, however, in its operation. This was emphatically pointed out by Conrad, in a pamphlet published in 1845, and further, in a report on the expropriation for the Dutch railway submitted to the Board of Management on the 28th of January, 1847. The refusal of the Government to modify this law in 1845, had afforded three landowners the opportunity to be so troublesome to Conrad on the Dutch railways, by purchasing and keeping possession of a lane near Delft, that to avoid it, and foil them, he conceived the, at that time, bold plan of what was called the "crooked line" (de kromme lyn), which was a divergence from the main line of 820 yards, in five reverse curves, in 720 yards, of which the curves had only 71 and 63 yards radius. This was run over in perfect safety by all the ordinary trains, from the opening on the 7th till the 10th of May, 1847, when the opposition ceased, and the "crooked way" was consigned to history. A description of this railway by Conrad, was translated into English by Mr. C. Manby, read before the Institution of Civil Engineers on the 16th March, 1844, and obtained the Walker premium. On the 8th of January, 1842, a royal decree was issued, ordering the establishment of the Royal Academy for Engineers at Delft, at which scientific training was to be provided, not only for engineers intended for the Waterstaat, but for those who were to be employed in the enterprises of industry and trade. The names of Lipkins and G. Simons stand honourably associated with this institution. Between 1842 and 1848, various matters pertaining to the Waterstaat were regulated, partly consequent on the Treaty of London (19th of April, 1839), and partly containing the approval of provincial regulations concerning enterprises of peat digging, planting of the dunes, the maintenance of sea dykes, &c., chiefly matters of provincial interest. Of more general interest were the royal decrees of 19th of April and 20th of May, regulating the conveyance of the railway from Amsterdam to Arnhem, its extension, and the construction of a branch line from Utrecht to Rotterdam, and the concession for the line from Maastricht to Aix-la-Chapelle. The year 1847 was made memorable by the formation of the Royal Institute of Engineers. From 1843, when Conrad was elected a member of the Institution of Civil Engineers in England, he had cherished the plan of giving a similar Institution to the Netherlands. Consequently, on the 24th of May, 1847, an address to a number of engineers was issued by F. W. Conrad, L. J. A. van der Kun, and G. Simons, in which the plan was laid down, and co-operation invited. In consequence, 82 gentlemen met as members of the new Institution in the building of the Royal Academy, at Delft, and F. W. Conrad was chosen president on the 24th of May, 1847. The royal sanction and permission to use the title of Royal Institution of Civil Engineers was granted on the 24th of February, 1848. In the year 1848 a revision of the constitution of the country took place, and the 9th chapter of it was devoted to the Waterstaat. Shortly after its publication a new organisation of the corps of engineers of the Waterstaat followed, the treatment of which we dealt with in our last article.*

LITERATURE.

Iron and Heat, Beams, Pillars, and Iron Smelting; Exhibiting in simple form the principles concerned in the construction of iron beams, pillars, and bridge girders, and the action of heat in the smelting furnace. By JAMES ARMOUR, C.E. With numerous illustrations. London: Lockwood and Co.

THE treatise at present before us bearing the above title is one of a series of excellent little engineering manuals now in course of publication by Messrs. Lockwood. In speaking of these works we perhaps use the word "series" unadvisedly, as each manual is perfectly complete in itself, but we have been induced to employ the term from the fact that the set of volumes to which we refer are all alike in size and general "get up," and are all—or at least all of them that have as yet come into our hands—of a thoroughly practical kind. In the preface to the volume now under notice, the author states that "as it is designed to benefit those who are more intimately acquainted with practical operations as workmen than with the principles on which practice is based, common arithmetic only is used in the treatment of the questions; and the endeavour is, rather to explain circumstantially the rules of common use than to develop new theories;" and this quotation might really be taken as the text on which the whole series of manuals to which we have been referring is based. In "Iron and Heat" Mr. Armour has well fulfilled the object set forth in his preface, and he has produced a work calculated to be of great service to the class for whom it has been written. The book may be said to consist of two distinct parts, the first treating of leverage, the action of strains of various kinds, the proportions of beams and girders, the resistance of columns, and the elasticity of iron; while the second part deals with the properties of iron, iron ores, and the smelting process generally. This is a wide range of subjects to deal with in a small octavo volume of 163 pages, printed in good sized type; but Mr. Armour has managed to accomplish the task simply by using as few words as possible to express his ideas, and by carefully excluding from the work any matter not strictly relating to the subjects of which it treats. In what we have called the first part of the book—namely, the first five sections—the actions of various strains on beams, girders, and columns are very clearly explained, and the rules are given in forms which render them available for practical use by any one acquainted with common arithmetic. The sixth section gives a general summary of the qualities of cast iron, steel, and wrought iron, while in the seventh is commenced an account of the smelting process. Mr. Armour's account of this process is necessarily, from the limited space at his disposal, somewhat rudimentary, but it is scarcely rudimentary in the sense ordinarily attached to that term. Our author's object evidently has been, not to save space by treating the subject in a vaguely general manner, but rather to obtain the necessary compactness by writing of what we may term a typical smelting process, and not attempting to treat of the modifying influences to which it is necessary to attend, when carrying out that process in actual practice. It thus happens that the second part of Mr. Armour's book, if regarded as a treatise on iron making, is exceedingly rudimentary,

* Between 1831 and 1839, Conrad had published several treatises on matters pertaining to the Waterstaat, which were collected by him, and published in 1849, under the title of "Verspreide Bydragen" (Scattered Contributions), in the hope that they might at some time prove useful for the compilation of a complete history of the Waterstaat.

whereas, if considered as a treatise on the process of smelting, it is very complete, the action of the heat in the various parts of the furnace being very closely followed, and the chemical actions explained. We must, however, take exception to the manner in which, in Section XI., Mr. Armour attempts to account for the different amounts of heat developed by the combustion of carbon into carbonic oxide and carbonic acid respectively. To explain what we mean, it is necessary to quote the following passage:

> Thus 1 volume of carbon = 1 lb., combines with the requisite 2 volumes of oxygen = 2.66 lb. to form carbonic acid, which is generated with 14,000 units of heat in the melting zone; and as we before remarked, these three volumes contract into the space of 2 volumes, while the addition of a fourth volume—viz., 1 of carbon—causes expansion to 2 double volumes, occupying the space of 4 volumes, which is equivalent to a double expansion, and hence the absorption of heat in the latent state.
>
> We have then, firstly, for the carbonic acid,
>
> Volumes. Volumes. Units. Pounds carbon. Units heat
> 3 occupying 2 with 14,000 ÷ 1 = 14,000;
>
> and, secondly, for the carbonic oxide,
>
> Volumes. Volumes. Units. Pounds carbon. Units heat.
> 4 occupying 4 with 14,000 ÷ 2 = 7000
>
> Thus we get 7000 units of heat for every pound of carbon in carbonic oxide, or in every 1.33 lb. of oxygen, whether in the acid or the oxide state; and as the units developed or found active in carbonic oxide have been found by actual test in melting ice to be only 4000 for every pound of carbon, it follows, as heat can no more be annihilated than can matter, that the expansion has hidden 3000 units; so that 4000 units × 2 lb. carbon = 8000 units, which being subtracted from 14,000 = 6000 units latent heat, available for heating the fixed oxygen of the ironstone when the condensed carbonic acid form is resumed on the extraction of that oxygen.

It will be seen that in this passage Mr. Armour neglects the quantity of heat which is rendered latent in effecting the gasification of the carbon when the latter is consumed with carbonic acid. When 2.33 lb. of carbonic oxide, containing 1 lb. of carbon, unite with an additional 1.33 lb. of oxygen to form carbonic acid, 10,000 units of heat* are set free, the carbon being in this instance already in the gaseous state; whereas, when 1 lb. of carbon unites with 1.33 lb. of oxygen to form carbonic oxide, 4000 units of heat only are rendered available. The accepted deduction from these facts is that, in the latter instance, 10,000 − 4000 = 6000 units of heat have been rendered latent in gasefying the carbon. Similarly, when 1 lb. of carbon is converted into carbonic acid by uniting with 2.66 lb. of oxygen, 20,000 units of heat are actually developed, of which 6000 become latent in converting the carbon to the gaseous state, and 14,000 units remain available as sensible heat. Hence there is not 7000, as stated by Mr. Armour, but 10,000 units of heat "for every pound of carbon in carbonic oxide, or for every 1.33 lb. of oxygen, whether in the acid or the oxide state." Moreover, it follows that, when 4.66 lb. of carbonic oxide, containing 2 lb. of carbon, are converted into carbonic acid by combination with the oxygen of the ironstone, the quantity of heat developed for supplying that rendered latent by the process of reduction, is not 6000, but 20,000 units.

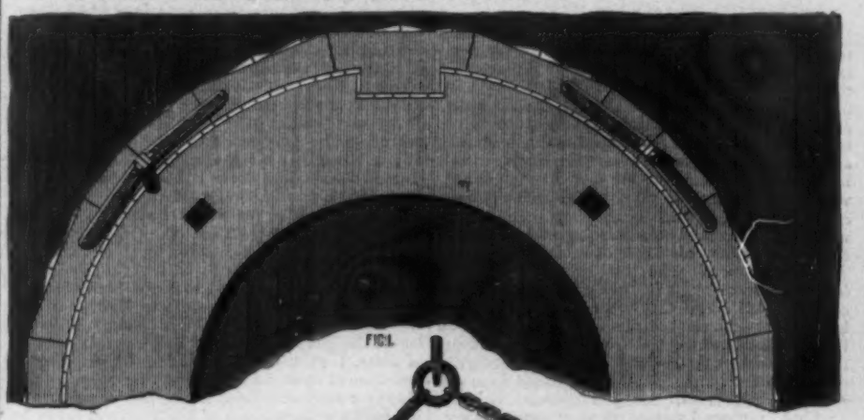
A few pages beyond that from which the above quotation was taken, Mr. Armour again underestimates the quantity of heat rendered latent in converting the carbon into a gaseous state, and this is the more remarkable as on an earlier page (page 113), he has given it at its correct amount, namely, 6000 units per pound. On the page last referred to, however, our author does not explain clearly that, when 3.66 lb. of carbonic acid are made to take up another pound of carbon, and are thus converted into 4.66 lb. of carbonic oxide, the sensible heat ultimately available is 8000 units, being that due to the conversion into carbonic oxide of 2 lb. of carbon. In a future edition, which the work under notice is sure to reach, we trust that these defects may be remedied.

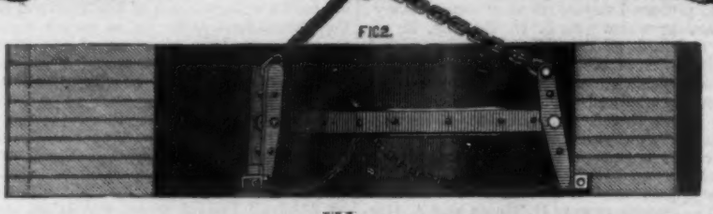
The concluding parts of Mr. Armour's book refer to the action of hot blast, and to Mr. Cowper's (named by a clerical error, "Fowler's") regenerative heating stoves, the action of which is clearly explained. Altogether, Mr. Armour has produced a book which will serve a very useful end, and which we can recommend to the class in whose interests it has been written.

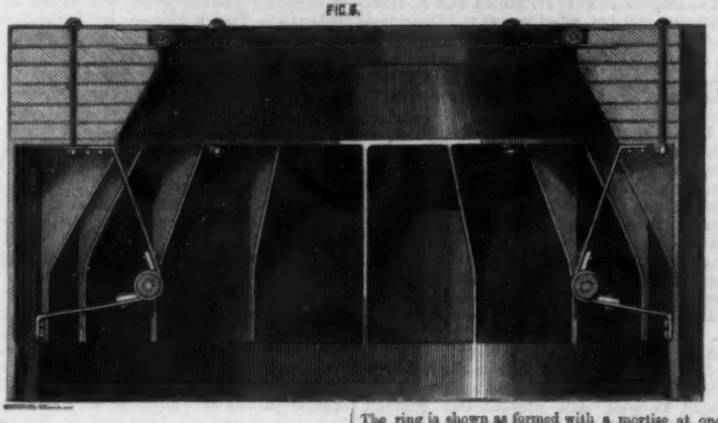
The United States Navy.—The secretary of the United States navy has appointed Commander Collins, navy constructors W. L. Hanscom and G. W. Mann, chief engineer C. B. Robie, and civil engineer C. Hastings, a Board to consider plans received for a floating iron dock for the repair of vessels of the United States navy. The Board has been in session at the Navy Department of the United States. Tenders are expected to be invited shortly for the construction of the dock. The amount appropriated by congress for the work is 1,000,000 dols.

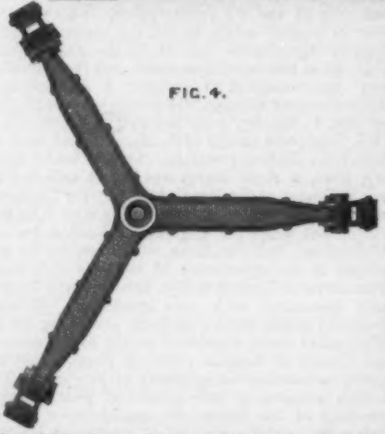
* We adopt Mr. Armour's figures to avoid confusion.

MILROY'S METHOD OF CONSTRUCTING FOUNDATIONS.









We publish, above, a design recently introduced by Mr. John Milroy, whose name is so well known in connexion with the excavator he has brought into extensive use, of a method of constructing piers or foundations of concrete or brickwork. The arrangement embraces two special features, one referring to the construction of piers either in complete circular or segmental sections, and the other to the use of a curb or shoe to be used with them. The design is adapted for any material, and the drawings, which we give above, refer specially to the employment of brickwork. The piers would be constructed of a series of annular sections or rings half of one of which is shown in plan in Fig. 1. Each section is founded on a platform, and within a frame, which may be constructed of wood and built up in segments. The ring is shown as formed with a mortise at one side, a tenon being placed at the other, for connecting or locking together a series of columns or cylindrical piers when constructing foundations for a continuous pier or quay.

Fig. 2 is a vertical section showing a ring being lowered down upon the portion of a pier or column in process of construction, and Fig. 3 shows the curb or shoe; Fig. 4 is a plan of the holder employed for lifting the rings and it is also shown in elevation in Fig. 2. This holder consists of a three-armed frame having levers jointed to the outer ends of the arms, and connected by chains to a central ring; these connecting chains are of such a length that when lifting force is applied to them the strain tends to draw in the upper ends of the levers, and force out their lower ends which are shaped to catch in cavities formed for the purpose in the bottom edge of the ring, and when the latter is being lifted, the strain acting as described prevents the levers from being loosened or displaced. When the ring has been lowered into its place, the upper chains are slackened and the lower ends of the levers are drawn inwards clear of the ring by means of three chains connected to their lower ends.

The rings are joined together with Portland cement, either by laying a bed of the cement in the usual way, or, after a ring has been lowered into its place, the joint between it and the one next below it is pointed with cement round the inside and outside, and cement is then run into the holes (see Fig. 1), provided for the purpose, and rammed well in so as to spread throughout and fill up a small space left for the purpose between the two rings. Bricks may finally be inserted in the holes, to act as dowels between the rings, and thus prevent any movement of them upon each other.

The curb or shoe, Fig. 3, consists of a thin cylindrical shell easily sunk, and presenting a sharp and elongated entering part, whilst from the space within elevation is accomplished without difficulty. The cylindrical shell is surmounted by a flat annular plate, the outer edge of which corresponds with and joins the top of the shell, and it is in addition supported by radial brackets or feather plates fixed or formed in the angle inside the shell. The bottom course of the pier rests upon the annular plate, and is fixed to it by bolts.

COMPOUND SURFACE CONDENSING MARINE ENGINES.

CONSTRUCTED BY MESSRS. T. RICHARDSON AND SONS, ENGINEERS, HARTLEPOOL IRON WORKS, FROM THE DESIGNS OF MR. C. SMITH.

(*For Description, see Page* 175.)

FIG. 2.

FIG. 3.

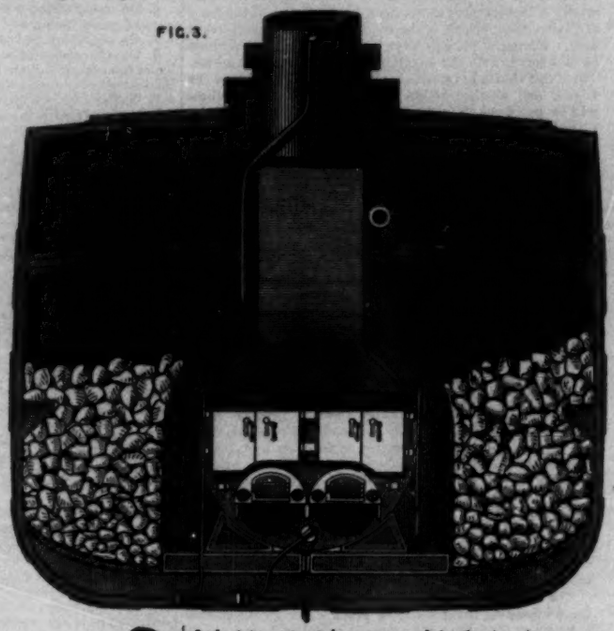
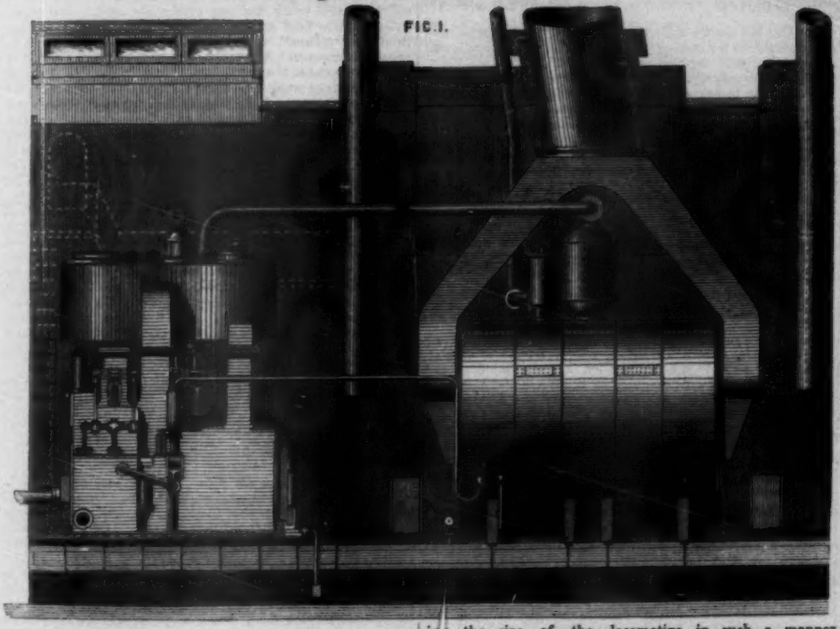


FIG. 1.



NARROW GAUGE RAILWAYS.

MR. CARL PIHL, who recently visited Canada to be present at the opening of the Toronto, Grey, and Bruce Railway of 3 ft. 6 in. gauge, made the following statements in the course of a speech on the occasion of a public dinner held at Toronto to celebrate the opening of the line:

"You doubtless would expect," said Mr. Pihl, "some exposition of what is termed the narrow gauge railway system, with which my name has been connected, from having been the first to carry out railways for general traffic on the gauge of 3 ft. 6 in. I was led to adopt this gauge rather than a narrower one, or the usual gauge of 4 ft. 8½ in. from the result of close calculation, which satisfied me that on it can be combined a maximum of capacity, comfort, efficiency, and safety with the minimum of cost of construction and working expenses. If, on the other hand, the gauge is reduced to 3 ft. or less, stability, comfort, and economy are sacrificed, while with the 4 ft. 8½ in. or greater gauge, expenses are multiplied in many departments without corresponding increase of useful effect. It must not be supposed, however, that economy depends wholly on the gauge. But rather that it is the basis on which to proportion the various works and carriages necessary to carry the required amount of traffic. Thus, by adjusting the size of the locomotive in such a manner that you get for example a pressure on each driving wheel of not more than 5 or 5½ tons, you are enabled to use lighter embankments, bridges, and rails, and decrease the expense of repairs in these important elements in the cost of a railway. I am often asked the exact difference between the cost of a railway on a gauge of 3 ft. 6 in. and 4 ft. 8½ in. It is difficult to make definite comparison, as every railway is different. I believe, however, that it may be stated generally that the narrower gauge can be built for say one-third less. In working I can give a better test by supposing a mixed train with three passenger coaches with places for 96 passengers, but containing only 60 people, and 14 goods wagons on a line with a ruling gradient of 1 in 100. In Norway the narrow gauge passenger coaches weigh 4.1 tons, goods wagons 3.3 tons, locomotive 16 tons. Estimating each passenger as 140 lb., and the load of freight as 70 tons, there is in all 148½ tons. On the 4 ft. 8½ in. gauge the three passenger coaches weigh 6.4 tons each, and freight cars, 4.3 tons, and engine 20 tons; adding the same amount of freight and passengers, the sum is 173½ tons, or 18 per cent. saved in locomotive power on the narrow gauge. Should the comparison be made with existing styles of carriages on 4 ft. 8½ in. and 3 ft. 6 in. railways in this country, the result would be much more favourable to the narrow gauge. But I must here warn against such statements as have appeared in the American papers lately, 'that in Russia on the 3 ft. 6 in. narrow gauge railway, some of Fairlie's engines, weighing 20 tons, had drawn 340 tons gross load up an incline of 1 in 80.'* Now, every engineer knows that until water runs up hill, the engine has not power to draw more than about half the load stated up a grade of 1 in 80. Also there has been a pamphlet advocating a gauge of 3 ft., published by gentlemen of the most unblemished motives so far as known. In their comparison of the working of 3 ft. and 4 ft. 8½ in. gauges, they charge the 4 ft. 8½ in. gauge with a locomotive three times as heavy for the same work. In both these cases the question of traction is quite apart from that of gauge and such unfair statements tend to discredit the systems which it is their intention to support. In proof that you have done well to adopt the 3 ft. 6 in. gauge I will mention that wherever the system has been examined by commissions, such as in Norway, Sweden, Russia, India, and France, the 3 ft. 6 in. has been approved, and with variations of 2 in. has been adopted for new lines in these countries as well as by eminent engineers for Queensland, Chili, New Zealand, Honduras, Java, and Japan, &c. I do not contend that the variation of one or two inches either way will make any appreciable difference in an engineer's estimate; but in comparison with the gauges of 3 ft. or less on the one hand, or 4 ft. 8½ in. or more on the other hand, I believe the 3 ft. 6 in. to have the advantage already stated. In Norway, where we have much frost and snow, these 3 ft. 6 in. railways have proved quite as efficient as the 4 ft. 8½ in., and have cost much less for maintenance and working expenses."

RAILWAYS IN NEW SOUTH WALES.—It appears that the cost of the line from Parramatta Junction to Picton in New South Wales, 40 miles in length, was 667,241*l.*, giving an average of 16,681*l.* per mile. From Picton to Goulburn, 81 miles, the outlay has been 1,022,927*l.*, giving an average of 12,628*l.* per mile. Upon the line from Penrith to Bathurst, 109 miles, the amount expended was 1,572,342*l.*, giving an average of 15,746*l.* per mile.

MESSRS. C. AND W. EARLE'S SHIPBUILDING WORKS, HULL.—The prospectus has just been issued of a new shipbuilding and engineering company at Hull, for the acquisition of the old-established works of Messrs. C. and W. Earle. The firm has long been held in high repute, and the reason of the present transfer to a joint stock company is the death of one partner, and the serious illness of the only survivor. The board of directors is one of unusual eminence and commercial strength, with Mr. Reed, late Chief Constructor of the navy, as chairman. The terms of purchase appear to be very reasonable, the consideration extending over 10 years, and the unpaid portion from time to time bearing interest at the very modest rate of 4 per cent. It is stated that the works have recently been removed to a new site on the bank of the Humber, with deep water sufficient to launch the largest iron-plated ships of war, and the works have abundance of land for present use and future extensions. Messrs. Chadwicks, Adamson, Collier, and Co. have negotiated this purchase, and formed the new company.

* [This quotation, of course, is an absurd one, the weight of the engines alluded to is 42 tons, not 20 tons, as erroneously given in the American journal from which Mr. Pihl derived his information.—ED. E.]

PROPOSED TUNNEL UNDER THE CLYDE AT GLASGOW.

THE enormous extent of the passenger traffic over the Clyde at Glasgow by the harbour ferries, together with the great danger attending the traffic, has led the Works Committee of the Clyde Trust to take action, with the view ultimately of constructing a passenger subway in lieu of the ferry at Clyde-street, which is the one that is most extensively used. Boring operations have been going on for some time at that ferry, with the sanction of the Works Committee. Three test shafts have been made, one on either side of the Clyde, and another within the quay wall. All of them will be put down to a depth of 85 ft., and all the results hitherto obtained are very satisfactory, showing that, so far as the soil is concerned, the construction of a tunnel would not only be practicable, but even easy of accomplishment. Estimates are now being prepared, in order to ascertain the cost of the undertaking, and the revenue likely to be derived therefrom. Several members of the Clyde Trust are quite in favour of the scheme, and there is every probability that before long it will assume a definite and practical shape.

In the month of December, 1864, a lamentable loss of life took place at the ferry already named, owing to the swamping of a ferry boat, which at that time was simply a two-oared boat capable of carrying twenty-four passengers, but that number was exceeded on the occasion referred to on account of a violent and headstrong rush of working men who were just returning home from work. Soon afterwards a small steam ferry boat was put upon that station; but the fact of nearly twenty persons being drowned at the time naturally led many persons to think of proper preventive measures against such a loss of human life. Amongst the schemes devised there was one which was privately submitted to the harbour authorities by Mr. James Deas, C.E., who was then engineer to the Edinburgh and Glasgow Railway, and had no expectation that he would ever be in the position of engineer to the Clyde Trust, the post which he now occupies. It is the scheme devised by that gentleman which is now brought under the consideration of the Trust.

The following is an outline of the scheme which Mr. Deas submitted along with the plans which he sketched to accompany his letter: He proposed a malleable iron tunnel from 9 to 12 ft. wide by 9 ft. high, the top being 3 ft. or so below the present bottom; the approaches to the tunnel at the two ends to be by means of sloping brick archways or tunnels of a similar width and height. The latter he proposed to carry from the side of the two streets leading to the ferry, a few steps being made at the entrance so as quickly to obtain a sufficient headroom for the brick tunnels under the streets running parallel to the harbour. The entrances could be covered over in a manner similar to the coverings placed over the entrance stairs to the cabins of steamboats. Of course the tunnel would be properly ventilated, and lighted with gas, and a toll might be charged similar to that now exacted at the ferries. It is believed that the additional safety of such a subway would induce many persons to avail themselves of its use who now never venture into the ferry boat; and it is not likely that the revenue of the Trust would suffer in the slightest degree.

Such a tunnel would doubtless bring several other advantages. The quay frontage at present occupied by the ferry stairs on either side of the harbour would be made available for ordinary quayage purposes, and hence there would be additional revenue from this source. The amenity of the quays would be improved by having them, as at present, subdivided by the ferry stairs; and the traffic on the river would be much facilitated by having the ferry boats dispensed with.

In the event of the scheme thus outlined, or any modification of it being adopted for execution, we shall take care to inform our readers from time to time of the progress made, and more especially of the means which may be had recourse to for the construction of the tunnel.

Plans for a similar work have also been prepared by Messrs. Storry and Smith, engineers, of West Regent-street, Glasgow.

THE INSTITUTION OF CIVIL ENGINEERS.

Subjects for Papers, Session 1871-72.

THE Council of the Institution of Civil Engineers invite communications on the subjects comprised in the following list, as well as upon others; such as—

a. Authentic details of the progress of any work in civil engineering, as far as absolutely executed (Smeaton's account of the Eddystone Lighthouse may be taken as an example).
b. Descriptions of engines and machines of various kinds.
c. Practical essays on subjects connected with engineering, as, for instance, metallurgy, or,
d. Details and results of experiments or observations connected with engineering science and practice.

For approved original communications, the Council will be prepared to award the premiums arising out of special funds devoted for the purpose.

1. On the application of graphic methods in the solution of engineering problems.

2. An experimental inquiry into the strains upon arched ribs, variously loaded, to ascertain the agreement between calculation and experiment.

3. On the methods of constructing the foundations of some of the principal bridges in Holland and in the United States.

4. On the construction of bridges of large span, considered with special reference to examples, now in progress or recently completed, in the United States.

5. On the most suitable materials for, and the best mode of forming, the surfaces of the streets of large towns.

6. On the advantages and disadvantages of subways, for gas and water mains, and for other similar purposes.

7. On the theory and practical design of retaining walls.

8. On the comparative efficiency of different steam and hydraulic cranes, and on the application of steam power in the execution of public works.

9. On the different systems of road traction engines, with details of the results in each case.

10. On the use of concrete, or béton, in large masses, for harbour works and for monolithic structures.

11. On dredging machinery, with details of the cost of raising and depositing the material.

12. On excavating by machinery, with a description of any excavating machines which have been brought into successful practical use.

13. On the various appliances and methods used in rock-boring and blasting, in this country and abroad, with details of the results obtained.

14. On explosives, as applied to industrial purposes, particularly nitro-glycerine, dynamite, and 'lithofracteur.'

15. On the gauge of railways.

16. On economical railway construction and working.

17. On the systems of fixed signals, and the connexion between signals and points, at present in use on railways.

18. On the details of construction of modern locomotive engines, designed with a view to economy, durability, and facility of repair, with particulars of the duty performed, of the cost of repairs, &c.

19. On the best descriptions of continuous brakes, which have been extensively employed on railways, and the general results of their working, both upon inclined planes and upon levels; and on the use of cast iron, wood, and other materials for brake-blocks.

20. On the best method of utilising the resistance of the piston, as a retarding brake power on railways.

21. On street railways, and the best mode of working them.

22. On the water supply of towns, including a description of the sources of supply, of the different modes of collecting and filtering water, of the various incidental works, of the distribution to the consumers, and of the general practical results.

23. On the theory and practical design of pumps, and other machines for raising water; as well as of turbines, and of water pressure engines.

24. On the employment of steam power in agriculture.

25. On the theory and practice of the modern methods of warming and ventilating large buildings.

26. On the laws governing the flow of steam and other gases in pipes, and on experiments to determine these laws.

27. On the best practical use of steam in steam engines, and the effects of the various modes of producing condensation.

28. On the results of the best modern practice in marine engineering, having regard particularly to economy of working expenses, by superheating, surface condensing, great expansion, high pressure, &c.

29. On mechanical appliances, worked by steam, for use on board ship, as substitutes for manual labour, in loading and discharging cargo, in raising the anchor, in working the sails, &c.

30. On the design and construction of gas works, with a view to the manufacture of gas of high illuminating power, free from sulphur compounds, especially sulphide of carbon; and on the most economical system of distribution of gas, and the best modes of illumination in streets and buildings.

31. On the maintenance, by sluicing, of the harbours on the coasts of France, Belgium, and Holland.

32. On the sea works at the mouth of the river Maas, and the effects produced thereby.

33. On the construction of tidal, or other dams, in a constant, or variable depth of water; and on the use of cast and wrought iron in their construction.

34. On steel, and its present position, as regards production and application.

35. On the safe working strength of cast and malleable iron and steel, including the results of experiments on the elastic limit of long bars of iron, on the rate of decay by rusting, on the effect of vibration or prolonged fatigue on the strength of railway axles, chains, shafts, &c., and on the relative extension and compression of wrought iron and steel under equal loads within the elastic limit.

36. On the means in use for sinking deep shafts through quicksands, or other shifting material.

37. On the various methods of draining distant isolated sections of mines.

38. On the best forms of air-compressing machinery and of hydraulic engines for conveying motive power to deep workings in mines.

39. On the theory and practice of the methods in use for the artificial ventilation of coal and metallic mines.

40. On the washing of small coal and the manufacture of artificial fuel.

41. On the preparation and utilisation of peat, and the machinery connected therewith.

42. On the systems and apparatus at present used in telegraphy.

43. On the pneumatic transmission of heavy trains through tunnels, and of light weights through pipes, with a comparison between the economy of the two systems.

It has frequently occurred that, in papers which have been considered deserving of being read and published, and have even had premiums awarded to them, the authors may have advanced somewhat doubtful theories, or may have arrived at conclusions at variance with received opinions. The Council would, therefore, emphatically state, that the Institution must not, as a body, be considered responsible for the facts and opinions advanced in the papers or in the consequent discussions; and it must be understood, that such papers may have medals and premiums awarded to them, on account of the science, talent, or industry displayed in the consideration of the subject, and for the good which may be expected to result from the discussion and the inquiry; but that such notice, or award, must not be considered as any expression of opinion, on the part of the Institution, of the correctness of any of the views entertained by the authors of the papers.

THE MANUFACTURE OF WIRE.

TO THE EDITOR OF ENGINEERING.

SIR,—The recent breakage of a submarine telegraph cable, which, interrupting our communication with Shanghai and elsewhere, is an event of so much commercial importance that I need scarcely apologise for the liberty I take in addressing you, and to call attention to the disadvantage which the ordinary telegraph cables suffer from, viz., weight. It requires but little consideration to understand that, if we had two wire cables whose strength was equal, but whose diameters were as 3 is to 5, the smaller, and consequently the lighter, one would be the best adapted for telegraphic purposes. But if, in addition to lightness, the wire the lesser cable was made of possessed greater strength through being annealed by a new process, which prevents its becoming brittle or rotten, surely we shall never continue laying down ocean telegraphs upon the old system. It is over fourteen years ago since the *Times** probably called attention to Mr. Allan's excellent system of inland and submarine telegraph communication, yet in the present day we are but little further forward. I believe, however, that a patent, lately taken out by Messrs. Hill, Ward, and Claus, for "improvements in the manufacture of wire," will give a fresh impulse to every kind of telegraphic manufacture in which wire is used.

It is scarcely necessary to explain to your readers that, in the annealing of wire preparatory to its being reduced in thickness, the rod from which it is made is first brought to a bright red heat, and then permitted to cool slowly, in order to get the metal to the requisite degree of softness to allow of its being drawn to a less diameter. That, also, while cooling the action of the air causes an oxide to form upon the metal, which, if permitted to remain, would prevent the wire being drawn thinner, and to remedy this the oxide has to be dissolved by means of a diluted acid, sulphuric acid being the one commonly used. This application of the acid at this stage causes the wire to become brittle or "rotten." It is then cleansed, and drawn finer in the usual manner. After having passed through two, or, at most, three holes, the metal has become so hardened that it is impossible to work it without the risk of breaking; so the process of annealing has again to be gone through, when a fresh scale or coating of oxide again forms on the surface of the wire, and has to be removed again in the same manner as before. And so it continues, according to the fineness of the wire, by which we can perceive that the finer the wire is the more determined is the action of the wire upon its quality.

Now it will be apparent to all that an invention which would prevent the access of air, and consequently the formation of scale during the process of annealing, must prove of immense value to the manufacturers of every kind of wire, but especially with telegraph wire. This has been accomplished by Messrs. Hill, Ward, and Claus's patent, which anneals the wire by immersing it in a bath of flux,† heated to the required temperature. The flux, naturally adhering to the hot metal, forms a coating, which prevents the metal's oxidation until it is cold, when it is removed from the annealing articles by the aid of hot or cold water.

I could go on, but I fear I have already trespassed too far upon your valuable space, and again apologising for the liberty taken,

I am, Sir, your very obedient Servant,

PROGRESS.

HOURS OF LABOUR ON THE CALEDONIAN RAILWAY.—On Saturday, a large meeting of railway employés connected with the Glasgow, South Side, Gartcherrie, Motherwell, and Carstairs mineral sections of the Caledonian Railway, was held at Motherwell for the purpose of considering what action should be taken in reference to the hardships incurred from long hours and the low rate of wages paid in many of the branches connected with the mineral department. A deputation of two men from each section was appointed to wait upon Mr. Britton, locomotive superintendent, Glasgow, with the view of presenting a petition to the directors, to restrict the working hours to ten hours per day, the time in no instance to exceed nine and quarter, except in cases of accident or necessity, the overtime for such work to be paid at the hour and quarter rate. After some discussion on the wages question, it was proposed that the wages of the firemen and brakesmen should remain as at present, as those branches are confident that with the proposed reductions in the hours of labour and the overtime payment, their weekly wages would upon the whole be increased. It is rumoured that in the event of the directors disregarding the claims of the men, there will be a kind of confederacy formed to make the Caledonian line the battlefield on which to begin the short hour movement throughout Scotland. The passenger engine-drivers have as yet taken no action in the matter, but it is currently reported that many of the pointsmen, who have the longest hours and are the worst paid class in the service, will join in the movement.

* April 8 and 22, 1857.

† The flux or fluxes used are chloride of calcium, hydrate of soda, or silicate of soda, as being cheapest and most suitable, but common salt and substances of a similar character may be also employed, with like results.

NOTES FROM PARIS.

PARIS, Sept. 11, 1871.

RAILWAY TRAFFIC.

THE railway receipts of the past week show an increase over those of the corresponding week of 1869. The Lyons Railway has gained 10 per cent. on its old system, and 24 per cent. on the new; the Orleans line 9 per cent. on the old *réseau*, and 14 on the new; the Western 13 and 17 per cent. respectively; the Northern loses 2 per cent. on the old system, and almost 38 per cent. on the new. The Central, as compared with last year, shows an increase of 34 and 15 per cent. These results are to be attributed to the business in arrear, but the companies are far from being able to give satisfaction to all the requirements of traffic, and to the continual complaints made. But these complaints appear to be of little use; there has, however, been formed in Paris, since about 15 months, a council of commerce and industry in matters of transport, and this body, whose action has been paralysed by the war and the insurrection, has published the first number of a bulletin, which will appear monthly. This syndicate will be able to render important services to manufacturers and merchants in maintaining their rights and interests against the powerful companies. The Government which has recognised the utility of the institution, has entered into relations with it.

M. GRAMME'S ELECTRO-MAGNET.

The electro-magnetic machine of M. Gramme, a description of which we lately published in ENGINEERING, has produced considerable interest in the scientific world. M. Bréguet, the able manufacturer of telegraphic apparatus, has adopted already two different types of this machine. The technical journals have published descriptions of them. We shall refer to this machine again when experience has supplied facts sufficiently numerous to enable us to form a definite opinion of its merits.

PETROLEUM.

M. H. Byanon in a note on petroleum presented to the Academy of Sciences, criticises the means generally employed to ascertain the degree of inflammability of the oil. The author finds this means defective and unscientific, and prefers to seek by the aid of a very simple and easily managed apparatus, the character of the vapour that disengages itself at various temperatures; he tests this vapour with the assistance of a column of water. The most volatile and inflammable products have a very considerable elasticity, sometimes superior to that of sulphuric ether, and the existence of 5 to 10 per cent. of these products is the most dangerous.

Apropos of the much disputed question of the origin of petroleum, M. Byanon affirms that in a laboratory trial, he has succeeded by a combination of carbonic acid and water under the simplest conditions, of obtaining in a small quantity an inflammable liquid, and having an odour somewhat analogous to the carbonate of petroleum.

THEATRES AND HYDRAULIC MACHINERY.

M. Queruel has recently established at the Gaîté Théâtre an hydraulic apparatus for working curtains and other moving parts of the stage. He has also worked out similar appliances which he proposes to apply to the new opera. M. Tresca, in the name of the Committee of Mechanical Arts, alludes favourably to this process, which he describes as follows: M. Queruel employs as a motor the water taken from the city mains under a pressure of three atmospheres. The accumulator is formed by the barrel of an hydraulic pump composed of a large copper tube 16 ft. 4 in. long, and 7¾ in. in diameter. The effect produced on the surface of the piston is 10,709 lb. The piston speed is about 3 ft. 3 in. per second. This power is transmitted to the objects to be moved by fourfold tackle, which reduces the power to one-fourth, while quadrupling the speed; by this means a large power, with a velocity of 13 ft. per second, is obtained, transferable by pulleys to all parts of the stage where it may be useful. This power, so easily managed, is under the control of a single attendant, who can operate it as required by handling an admission cock.

In an earlier application, which was in operation from March to July, 1870, at the Gaîté Théâtre, M. Queruel moved scenes in the ordinary way by rollers and cords, to which the apparatus imparted the movement. He is able also to give movement to carriages on which a vessel is mounted to cross the stage, and the apparatus is sensitive enough to give a motion that is in complete accord with the measure of the orchestra.

The arrangement which has so well succeeded in a simple instance may be extended to the greater part of the now complicated theatrical movements; it could be combined with the employment of large accumulators in the positions when they would be necessary, and ought to supersede the use of the complicated counterweights now employed in our theatres, the mechanics of which have stood still for a century.

A LONG AMERICAN FERRY.—A plan has recently been proposed for the transportation of cars laden with grain from Sheboygan, Wisconsin, directly across Lake Michigan to Pentwater, Oceana county, Michigan. This lake ferry will be 60 miles in width, and the boats are to be constructed like those which ran across the Susquehanna at Fort Deposit before the erection of a bridge.

BESSEMER'S HEAVY ORDNANCE.

FOR some time past, Mr. Henry Bessemer has been devoting his attention to the construction of heavy ordnance, and the development of a new system by which a weight of projectile may be fired far exceeding anything that has been yet attempted, combined, at the same time, with a lighter form of gun, requiring the employment of less metal in its construction. To achieve this end, he seeks to consume his powder charge in such a manner as to utilise the whole of its effective force, and, at the same time, to avoid throwing any sudden and excessive force upon the gun. Such a design affects, first, the construction of the gun, and, secondly, as a matter of course, the form of the projectile. Of the many arrangements which have been designed by Mr. Bessemer, and which have succeeded one another as he arrived more nearly to practical results, we have selected one of the earlier forms, reserving the publication of other and more advanced modifications till a later period; and here we may remark, that Mr. Bessemer is at the present time having constructed a monster piece of ordnance which shall embody his latest designs, and the trials of which will subject his theories to the extended test of actual experience. In the largest description of rifled ordnance now in use, the sudden explosion of the heavy powder charge required to project the elongated shot is so great, that a thickness of metal at the breech about equal to that of the bore, is required to resist the tendency to rupture the shock occasions. This necessity places comparatively confined limits upon the size of heavy guns, and the weight of projectiles employed. Again, the sudden energy called forth by the powder explosion which exerts so destructive an influence on the breech of the gun, decreases as the shot, acquiring velocity, moves along the bore of the gun, until, as it reaches the muzzle, the final pressure upon it is far less than that which originally started it into motion. To equalise this force then, and exert upon the projectile a constant pressure along the gun, is the first object the inventor seeks to obtain, and he anticipates reckoning the weight of shot, not by pounds but by tons, which with perhaps a somewhat low velocity would, if fired against armour-plated ships and forts, fall upon them and crush them.

But in so greatly increasing the weight of the shot, the inventor naturally increases the length of his gun, considering a barrel of, say 50 ft. in length, to be necessary for his purpose. In this barrel there would be generated a series of continued or repeated explosions, which would exert a comparatively low and equal pressure during the whole time that the projectile traverses it.

Thus, in the present system a given charge of gunpowder may exert at the moment of explosion a force of 60,000 lb. per square inch on the chase of the gun, and by the time the projectile has traversed a distance of 10 ft., the pressure may be reduced to a mean of 15,000 lb. per square inch throughout the entire length. Mr. Bessemer proposes to substitute for this violent and unequal action a continuous force of only some 3000 lb. to the inch, maintained upon the shot throughout the entire length of its extended travel along the bore of the gun, hoping to obtain an equivalent duty with a vastly reduced strain.

The engravings on the next page will explain the mode in which Mr. Bessemer has embodied his ideas. Fig. 1 is an elevation, Fig. 2 is a longitudinal section of part of the gun, and Fig. 3 a cross section. The inner tube of the gun may consist of several thick plates of iron, each bent into a tube, and welded, the inner and outer surfaces being bored and turned so as to receive a series of steel hoops placed on hot, and exerting an initial force on the gun. At the ends of the inner tubes are flanged hoops for the purpose of connecting the several lengths together by bolts.

The breech of the gun may be secured by a movable breech plug screwed into the end of the tube, and made gas tight by an expanding metal elastic cup, forming a knife edge on the plug, and forced against a ring of copper or other soft metal let into a groove formed around the breech for that purpose. This breech piece is shown at *c*, having a knife edge. The removal of the breech piece is effected by the rod, *g*, fastened into the rear of the breech, and supported in a bearing suspended from a crane; a balance weight is fitted upon the end of the rod, having handles for the purpose of turning round the breech piece.

In order that a continuous supply of gas under pressure may be generated and made to act on the projectile as it advances, a cartridge or powder chamber is provided, which fits loosely inside the gun; it consists of a cylindrical mass of steel, in which a large number of small holes or chambers have been drilled parallel to the axis of the gun. From 20 to 100 of these chambers are made according to the size of the ordnance, and varying from 2 to 5 in. diameter. The explosive material is placed in these cells. By preference, Mr. Bessemer recommends the use in each chamber of a number of separate charges of powder, separated from each other by diaphragms having a fuze for communicating the ignition, or else parted by a thin layer of meal powder. The quantities of powder in these charges increase at every succeeding discharge of the series, and the intervals of time between the discharges diminish, so as to keep time with the increasing velocity of the projectile, and thus keep up the pressure in its rear nearly uniform throughout its entire movement from the breech to the muzzle of the gun.

In Fig. 2 the cartridge above described is shown in its proper position within the gun, as well as in end elevation, Fig. 4. In both these figures the cells will be seen which contain the powder charge as well as the diaphragms dividing the powder itself. Each of these diaphragms is pierced with a small hole, so that the charges are fired in rapid succession. The powder is ignited by percussion caps contained in a separate cell, *a*, fastened into the central part of the cartridge, and behind the cap is a small steel rod fitted so that it can be easily moved. In a line with this rod is a similar one, *l*, passing through *g*, so that on receiving a blow at its outer end it comes in contact with the former, and strikes the cap. The cells of the cartridge are preserved from injury, and the charges are kept dry by a soft metal capsule covering the end of the chamber. As shown, the cartridge can be easily removed after it has been fired.

It will be understood that the powder in the various cells of the cartridge is ignited at the mouth of each cell, but they may be so arranged that the cells may be fired successively as the shot advances along the gun, and various means may be adopted for firing the charges, such as a central fuze communicating with each cell, or a suitable electrical apparatus actuated by the projectile itself.

In Fig. 2 is shown a nearly spherical shot, of a reduced diameter in one direction, where a portion has been cut away, so as to form a flat band around it. Thus, for a gun of 2 ft. bore, the shot may be 26 in. cut down to 24 in., as shown. The advantage of such a projectile over a spherical shot, is that there would be less windage, and that no rotation could be set up in the passage of the projectile through the gun, thus insuring a greater accuracy of fire.

In Figs. 6, 7, 8, are shown the elongated projectile proposed to be used by Mr. Bessemer, in which a part of the powder charge is inserted in the rear of the shot, or in an auxiliary chamber, to obtain rotation. In this arrangement a separate charge is placed in the shot, as shown, and the latter is provided with openings at the rear, placed tangential to the circumference; the ignition of this supplementary charge at once gives additional impetus and rotation to the shot as it passes along the gun. The powder is placed in the recess at the rear of the shot, firmly compressed in it, and afterwards partially bored out, as shown, to insure such rapidity of fire that the whole may be consumed before the projectile quits the gun. The degree of rotation would of course depend on the amount of powder consumed, and the size and direction of the openings through which the high pressure gases escaped. As shown in the drawing, the central opening through which the projectile is loaded is closed with a plug bored out in the middle, and fitted with a fuze, by which the charge is ignited from the first flash that proceeds from the cartridge of the gun.

We may now describe, in a few words the means designed for maintaining a succession of rapid discharges from the cartridge by help of the projectile in its passage along the gun. At short intervals, along the chase of the gun, small holes are drilled in pairs, *r s*, into which insulated wires are fitted. Both on the inside and outside of the gun, non-conducting screw caps are placed to preserve the insulation. The ends of the rods or wires stand sufficiently in relief on the inside of the gun to be touched by the projectile as it advances, and metallic contact between a pair is effected, and the ignition of a powder charge in a cell of the cartridge is effected by means of an Abel's fuze and a battery. In this way the whole of the cells may be discharged successively, and a comparatively uniform pressure maintained, whilst the shot traverses the 50 or 60 ft. of gun barrel, the maximum pressure being regulated, of course, by the amount of powder in each cell. This arrangement is shown in Fig. 5, where it will be seen that the cartridge forms the actual breech of the gun.

We refrain for the present from making any comments upon Mr. Bessemer's novel and very striking designs. They possess a vast amount of characteristic ingenuity, and will, if attended with success, effect a greater reform in the construction of heavy guns and armour than has yet been dreamed of. We shall have, however, to refer to the subject again and again, as Mr. Bessemer has effected many important modifications in his plans, and is engaged in perfecting the modes of mounting and operating his monster ordnance. Besides, as we said, he is now occupied in manufacturing a full-sized gun for subjecting his theories to the test of actual practice.

THE EX-CHIEF CONSTRUCTOR OF THE NAVY.—The statement which has appeared in some of our contemporaries, to the effect that Sir Spencer Robinson and Mr. Reed are to be joint managing directors of a shipbuilding company at Hull, is not altogether correct. The truth is that a company is being formed to purchase and work the establishment of Messrs. Earle, at that place, with Mr. Reed as chairman and managing director, and Sir John Brown, of Sheffield, as deputy chairman; while Admiral Sir Spencer Robinson has consented to form one of the board of ordinary directors, thus paying no small compliment to Mr. Reed, his former subordinate officer at the Admiralty. Mr. Reed has recovered from his late accident in Germany, and is at present in Monmouthshire, with the Right Honourable W. Massey, late chairman of the House of Commons committee, and with Mr. Graves, the mayor of Manchester, organising the working operations of the large estates, mines, and iron-making establishments of Nantygio, Blaina and Beaufort, which have lately been brought together under the proprietorship of a limited company, of which the three gentlemen just named are directors.—*Standard.*

BESSEMER'S IMPROVEMENTS IN THE CONSTRUCTION OF HEAVY ORDNANCE.

(*For Description, see preceding Page.*)

FIG.1.

FIG.2.

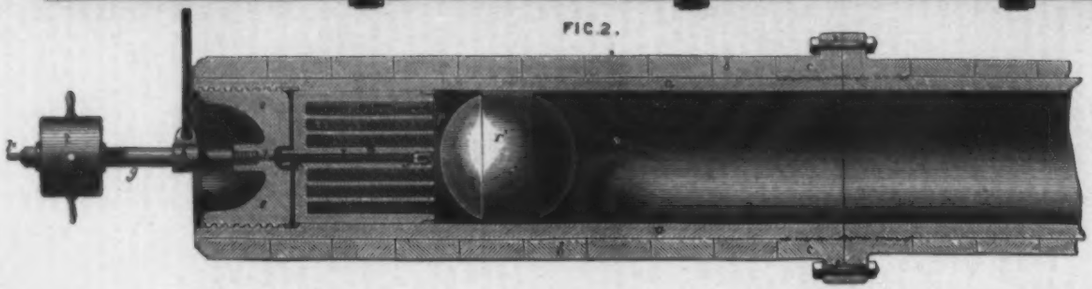


FIG.3.

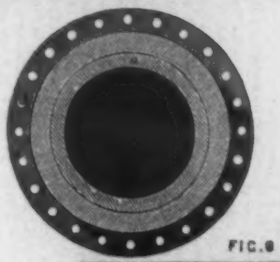


FIG.4.

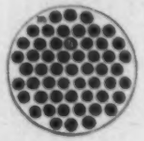


FIG.5

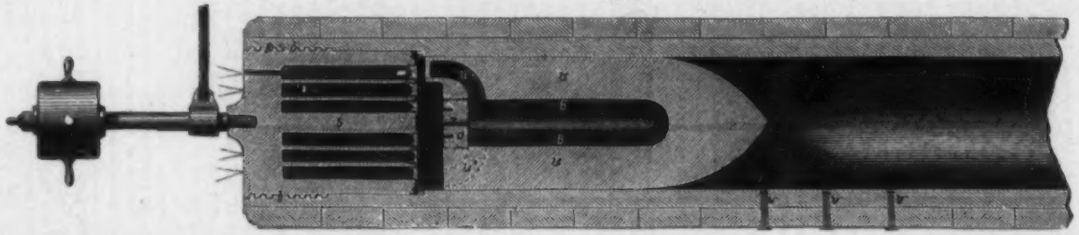


FIG.6

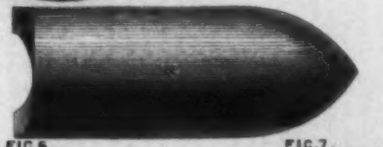


FIG.6.

FIG.7.

FOREIGN AND COLONIAL NOTES.

Bombay, Baroda, and Central India Railway.—Floods have caused several interruptions on the Bombay, Baroda, and Central India Railway. The Mhye Bridge has been damaged, and that over the Watruk has been carried away.

The Upper Mississippi.—The United States Government has been for some time engaged in dredging out the channel of the Upper Mississippi, and recent reports state that large boats will in future be able to pass up from Dubuque to St. Paul, Minnesota. The channel has been scraped out to a depth of 4 ft. over all the troublesome sand bars, and large and dangerous snags have been removed. At Red Rock bar, however, the channel takes an abrupt turn and sets directly across the river, and the difficulty in navigation consists in turning the long boats without striking the points of the bars above and below.

The South Australian Telegraph.—The South Australian Government has adopted vigorous measures for making up for the delay which will be occasioned in the execution of the great Australian overland telegraph, through the return of the Gulnare with Messrs. Darwent and Dalwood's party. The completion of the line by the end of the year is still talked of.

Iron and Steel on the Intercolonial Railway.—All the bridges on the Intercolonial Railway, with the exception of that at Rovière du Loup, will be of iron. Considerable quantities of the steel rails to be used have been received, and have been distributed ready to be laid. The laying of the permanent way has, indeed, been commenced in some localities.

Victorian Railways.—It has been announced that the Victorian Government proposes to call for tenders for the works of the third and last section of the North-Eastern Railway of Victoria which will be 62 miles in length or thereabouts. The tenders will be received in the course of next month (October). The works on the first section of the line which is to run from Melbourne to Albury on the Murray river have been pushed forward with energy during the past favourable season. The section is laid with steel rails. The first work of any importance is the bridge across the Moonee Ponds, which is 137 ft. long and which is built of iron girders laid on abutments and two piers of strong masonry. The work of sinking cylinders for bridges across the river Goulburn and lagoons at Seymour is being pushed forward, but the progress made from the nature of the work is necessarily slow.

Tramways in the Argentine Republic.—Tramways appear to be doing well in the Argentine Republic. The Billinghurst tramway has been opened to the suburb of Almargo, and the city of Buenos Ayres Tramway Company has laid down a new line to Calle Corrientes. Mr. Hood, engineer of the National Tramway Company, has arrived out.

Railways in the Madras Presidency.—An official paper shows the net profits realised on the several railways in the Madras Presidency for the official year 1869-70. It appears that the profits realised on the Madras Railway amounted to 3,070,123 rupees; on the Great Southern of India Railway to 300,134 rupees; and on the Carnatic Railway to 8120 rupees.

Water Works at Monte Video.—Water works have been recently inaugurated at Monte Video. The commercial prospects of the undertaking are considered favourable.

Progress of Chicago.—It is time to have a few more statistics in illustration of the material progress of Chicago. An unofficial census taken in May, 1871, estimates the resident population at 334,270, viz., 170,276 males and 163,994 females. Thirty years ago Chicago was just struggling into existence.

Montreal New City Hall.—Tenders have been invited for a new city hall at Montreal. Operations will not be commenced until next spring, and the hall will be completed in July, 1875.

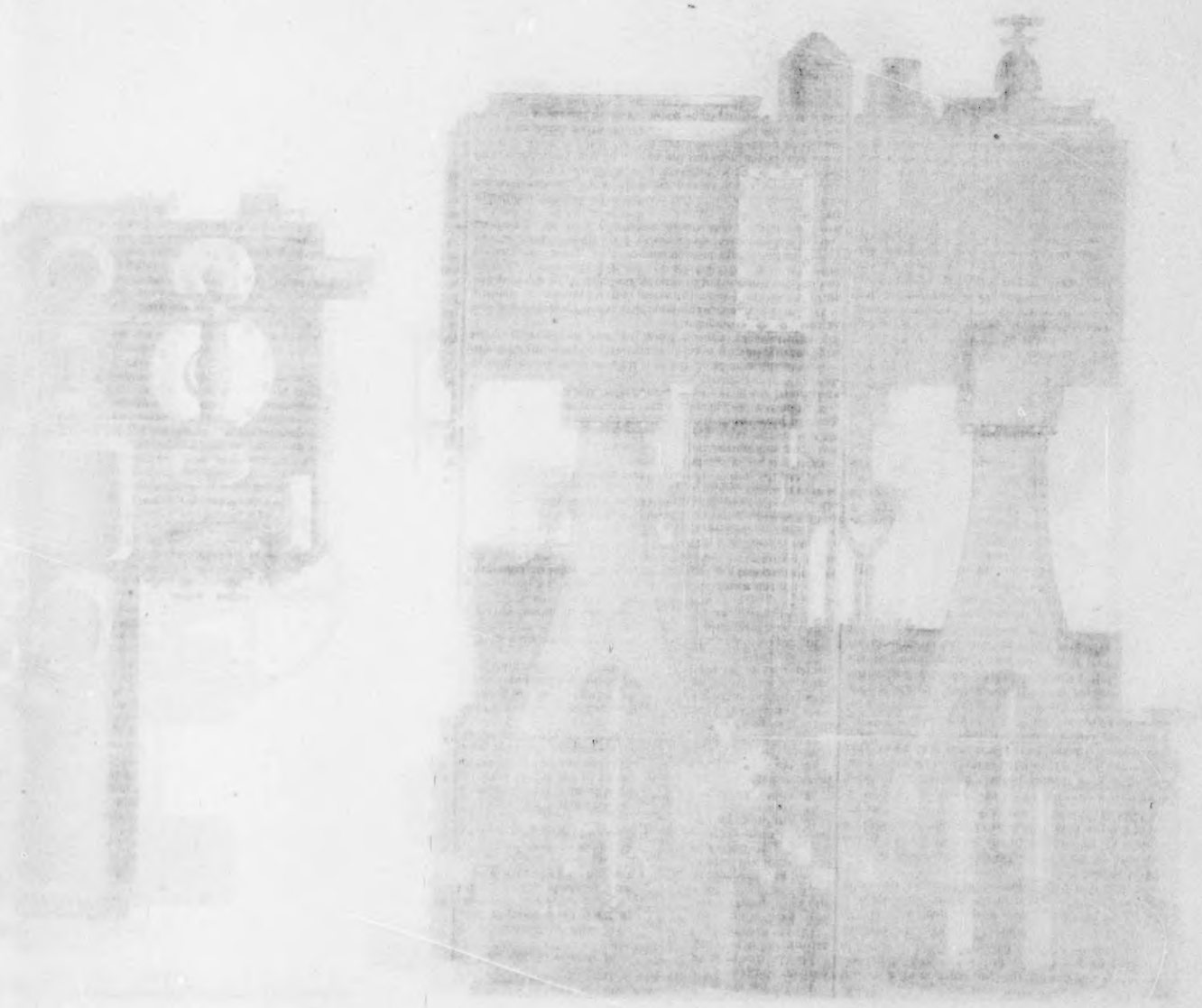
Brazilian Railways.—Messrs. Joquine de Souza Murta and Joao Gomes do Val, engineers, have received instructions from the Ministry of Agriculture to make the necessary surveys and estimates for the proposed extensions of the Bahia and Pernambuco lines to the Upper San Francisco. In San Paulo a contract for the Sorocaba Railway has been signed by the president of the province and the directors of the company, and it is announced that Dr. Paulo Sauza is occupied with preliminary surveys for the prolongation of the Itu line to the Tieté. The working expenses of the San Paulo Railway have been reduced to the remarkably low ratio of 36.17 per cent.

Intercolonial Railway.—The Intercolonial Railway Commissioners have completed their inspection of the works on the line. They express themselves satisfied, upon the whole, with the progress made. The bridging of the Meramichi has proved, however, a much more formidable affair than the reports and plans of the engineers had led all concerned to anticipate. The depth of mud is so much greater than those plans showed that an entire change in the mode of construction will probably be found necessary.

Pisco and Ica Railway.—This Peruvian line has recently been officially inaugurated. The line is 46 miles in length, and connects the port of Pisco with Ica. Mr. George Bugh has acted as chief engineer. The masonry work was executed by Mr. O'Donnell.

Surveys in Manitoba.—In all, 24 surveyors have been set to work in the new Canadian province of Manitoba. They will, however, be almost lost in its vast solitudes.

International Telegraphic Congress.—The International Telegraphic Congress proposed to be held this year at Florence is postponed. Colonel Robinson, who was to have represented the Indian telegraphic service at the congress, had left Simla before notice of its postponement arrived; the gallant colonel continued, however, his homeward journey taking furlough, instead of proceeding on special duty. The congress is only postponed until next year. Major Champain is to represent the Indo-European line; and one of the superior authorities of the English post-office will attend on behalf of the British telegraphs.



COMPOUND SURFACE COND

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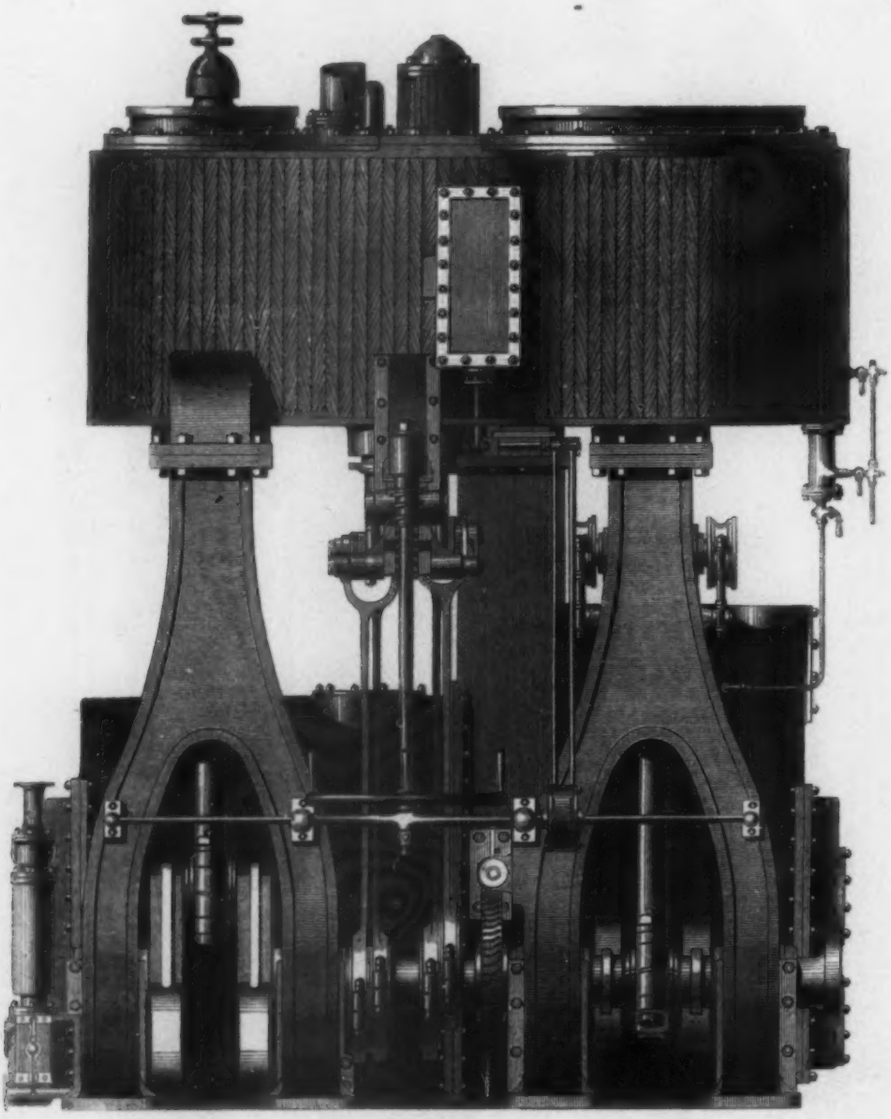
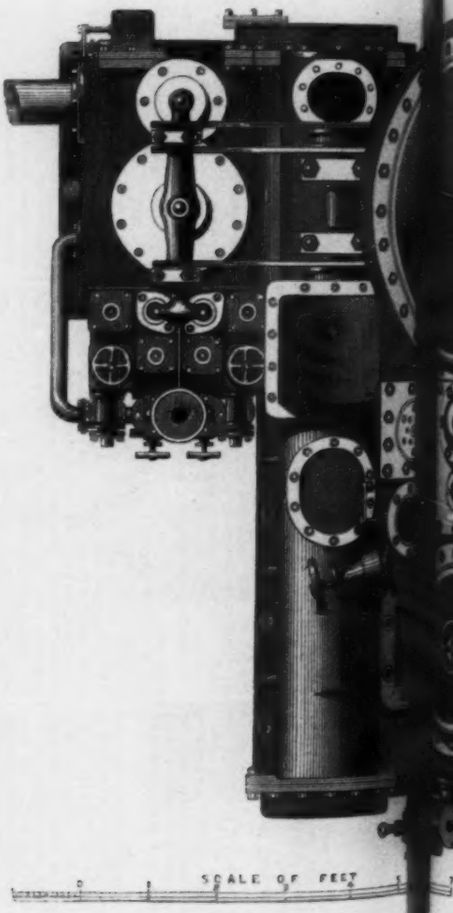
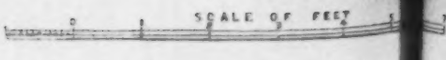


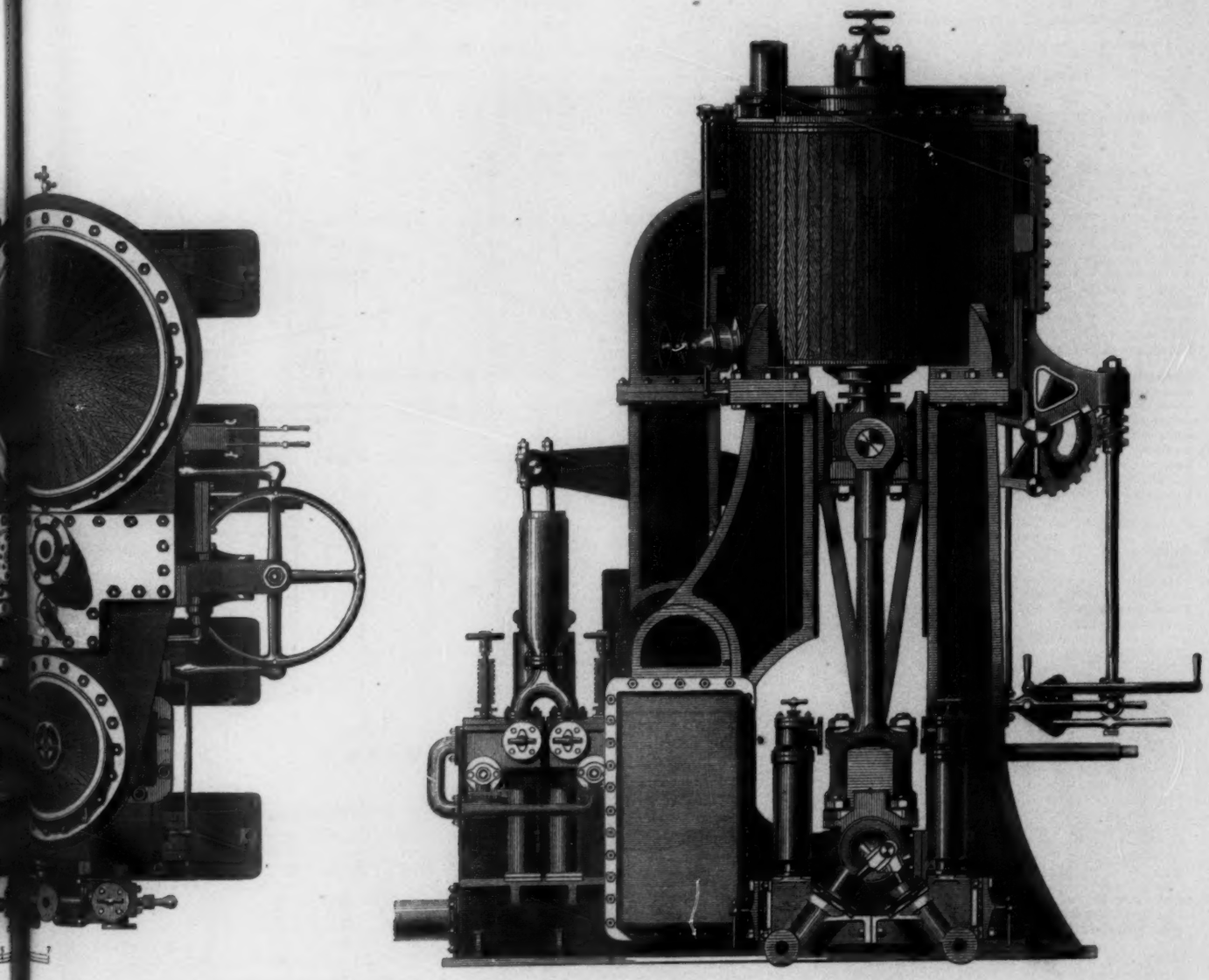


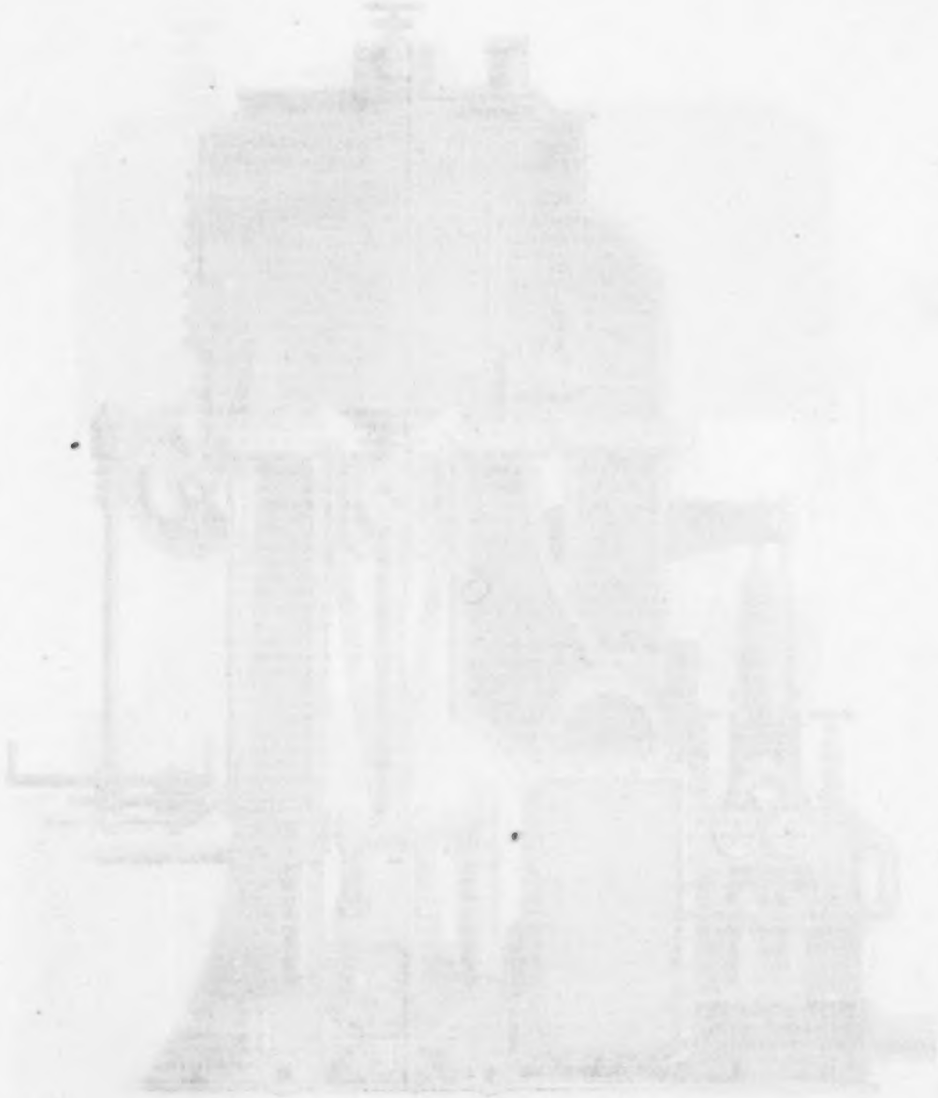


ISING MARINE ENGINES.

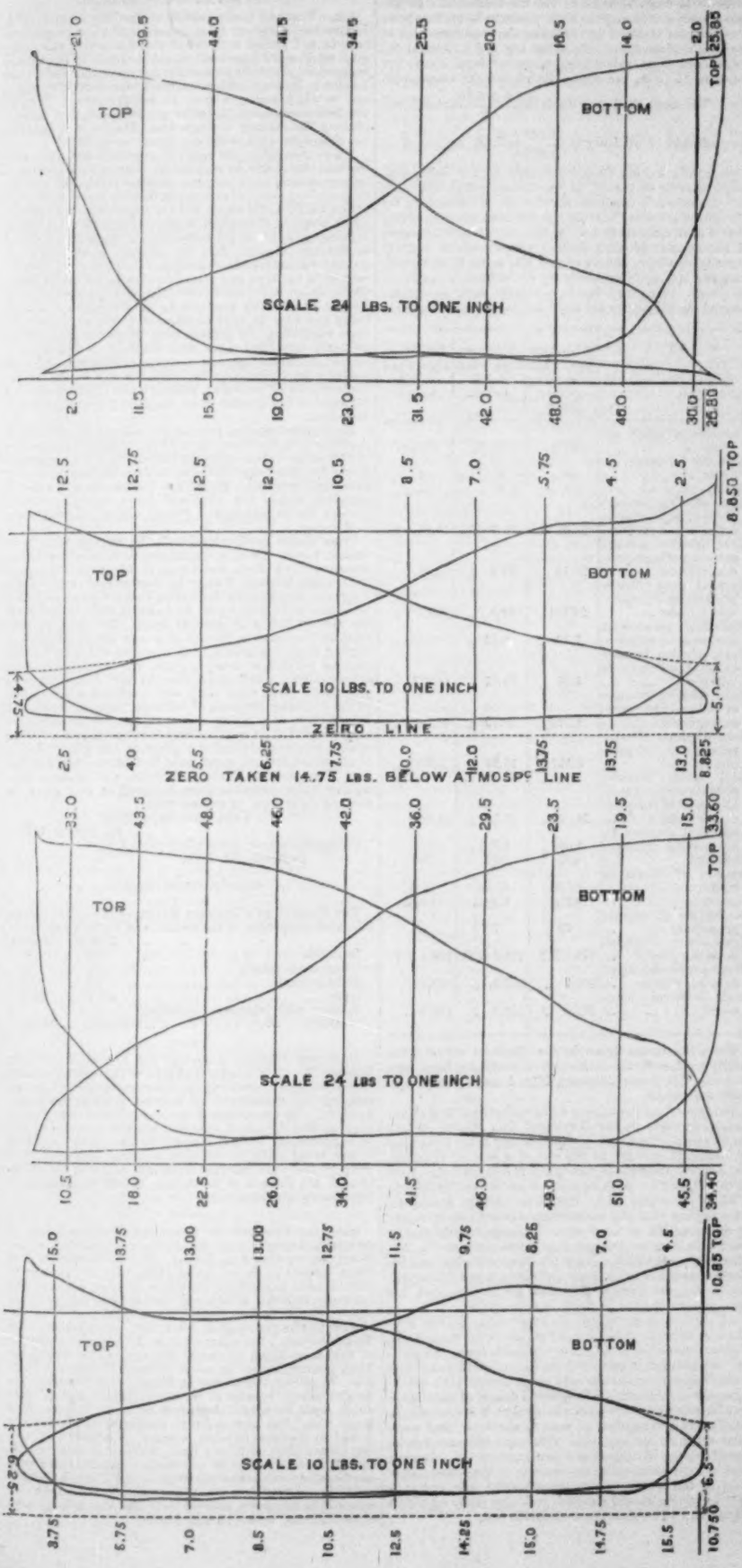
POOL IRON WORKS, FROM THE DESIGNS OF MR. CHARLES SMITH.

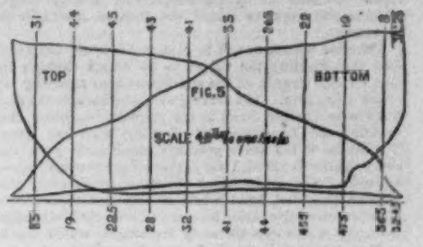
ge 175.)

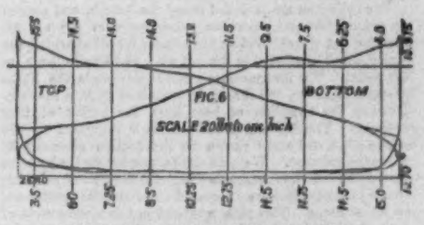




INDICATOR DIAGRAMS FROM COMPOUND MARINE ENGINES.


TOP
BOTTOM
SCALE 24 LBS. TO ONE INCH
SCALE 10 LBS. TO ONE INCH
ZERO LINE
ZERO TAKEN 14.75 LBS. BELOW ATMOSPH LINE
SCALE 24 LBS TO ONE INCH
SCALE 10 LBS. TO ONE INCH





COMPOUND MARINE ENGINES.

A FEW weeks ago, in the course of our account of the meeting of the Institution of Mechanical Engineers, at Middlesbrough, we had occasion to notice favourably the excellent type of compound surface condensing marine engines, which the members had the opportunity of examining at the works of Messrs. Richardson and Sons, of Hartlepool. Of these engines, which are constructed from the designs of Mr. Charles Smith, the manager of Messrs. Richardson's works, we are enabled, this week, to publish a two-page engraving, which will explain their principal features, whilst we also give on the present page other views which show the manner in which the engines and boilers are arranged in the vessel.

The principal distinction between the engines illustrated and those of the usual inverted type, is that a separate massive bed-plate casting is dispensed with, without in any way compromising the strength or rigidity of the engine. Referring to the engravings, it will be seen that the crank shaft is supported on four short stiff brackets, cast on the condenser, and united in front by the forked columns, between the legs of which the cranks and connecting rods swing, thus enabling the strain between the cylinders and the crank shaft to be resisted in the most direct possible manner, while at the same time the crank bearings and boilers are rendered very accessible.

The condenser tubes are horizontal, and in two sections, the water passing first through the lower and returning through the upper section to the main discharge pipe at the top and after end of the condenser. The condenser tubes are packed on the plan introduced at Messrs. Richardson's by Mr. George W. Jaffrey, and illustrated and described by us on page 244 of our tenth volume.

The ends of the condenser are planed flush, and the doors entirely embrace the tube plates, and form the necessary water passages. The after door covers the discharge side of the circulating pump, which is on the end of the condenser, and thus conducts the water direct into the condenser tubes. The quantity of water sent through the condenser by the circulating pump is regulated by a valve on a by-pass, which enables any desired proportion of the entire discharge of the pump to be returned from the delivery to the suction side. This mode of regulating the current of condensing water has the great advantage of enabling the circulating pump to be at all times worked full, thus obviating the knocking which takes place when the suction of such a pump is throttled, and the pump barrel consequently only partly filled at each stroke. A large space surrounding the barrel of the air pump—which is cast in one with the condenser and circulating pump—forms a capacious air vessel for the latter pump, which is double acting; and the part of the condenser raised at the after end, to support the pump levers, is further utilised as an air vessel for the air pump.

To provide for the air-pump discharge in the event of leaky tubes, &c., a circular cupped valve seat is fitted in a diaphragm separating the hot well from the circulating discharge passage; on this cupped valve seat a stout india-rubber valve is secured by a central guard in the ordinary manner, this valve, whilst thoroughly preventing any leakage of salt water into the hot well, opens on the slightest internal pressure, and permits any excess of water from the air pump to be discharged through the circulating pump discharge pipe. A 3-in. air pipe to permit the discharge of air in ordinary working is fitted to the hot well and carried above the load-water line.

Two feed pumps are attached to the hot well, and worked by the same crosshead as the air and circulating pumps. The feed pumps are fitted with suction cocks, and non-return valves on the suction and discharge pipes respectively, which enables the valves of either of the pumps to be examined whilst the other pump is working—an excellent

arrangement. The bilge pumps, which are worked by a short crank on the forward end of the crank shaft, are similarly fitted, rapid examination of their valves being further provided for by the adoption of a single-hinged crossbar and screw to secure the door, as shown in the engravings.

The slide valves, as will be seen, are between the cylinders, thus enabling the valves to be drawn through the door on top, directly off the spindles without removing any of the valve gear. The arrangement also permits the drag links to be attached direct to the reversing quadrant, thus avoiding the intervention of reversing shaft and levers. The details of the valve gear are particularly good, and every facility is afforded for taking up any looseness caused by wear. The arrangement of the reversing gear, also, with its horizontal hand wheel is very convenient. The high-pressure valve casing is separated from the low-pressure casing by means of a bolted-in diaphragm, which can be readily removed if required, giving ample room for a workman between the valve faces of the two cylinders.

The cylinders are jacketed round the barrels, and also on covers and bottoms, provision being made at the top for blowing out the air, and at the bottom for discharging the water which is carried to the hot well, and thence back to the boiler. The intermediate receiver surrounds the high-pressure cylinder, and the steam contained in it is thus exposed to the radiation of heat from the jacket of that cylinder. The draining of the jackets is regulated by the gauge-glass and cocks shown on the bottom after-end of the large cylinder. We believe that marine engine builders would find it an advantage to adopt the method of draining steam jackets which we suggested some months ago for use on locomotives. This plan consisted in the employment of a small pump drawing the water from the jackets and delivering it direct into the boiler. The pump would be so situated that the water would drain directly into it, and it should be of such size as to be able to remove the maximum amount of water produced in the jackets. When there was less than this maximum amount to remove, the pump would merely draw a little steam. As the pump would merely have to deliver the water against the difference of the pressures in the steam jackets and boilers, the power required to work it would be insignificant, and it would possess the advantages of delivering the water into the boiler at nearly the full temperature of the steam, while the jackets would be kept clear of water without attention on the part of the engineer. The delivery pipe from this pump to the boiler should be lagged to prevent loss of heat.

The small chest seen in front between the cylinders contain a hand-starting valve for the large cylinder, and in this chest, combined with the starting valves, are two hinged clack-valves, which permit the cushioned air in the low-pressure cylinder at starting to escape into the low-pressure valve casing. These clack-valves also perform a double function, serving as ordinary water-escape valves for the low-pressure cylinder.

The usual boiler fitted with these engines, is of the double ended type shown by our engravings on the preceding page, and described in ENGINEERING of the 4th of August last, page 79. We may repeat here, however, that these boilers are butt jointed and double rivetted, both inside and outside covering stripe being used at the longitudinal seams. The boilers are fired from both ends, there being a central uptake from which the tubes return to the ends of the boilers. A simple arrangement is provided for admitting air at the bridge, and the boilers are thus rendered capable of burning north country coal very efficiently. The manner in which the boilers are arranged in the vessel is clearly shown by the engravings on the preceding page.

Regarding the performance of the engines above described, perhaps the accompanying diagrams with the worked out coefficients will form the best criterion. It may be mentioned, however, that the consumption of fuel ranges from 1¼ lb. to 2 lb. of coal per indicated horse power per hour. Of the diagrams we engrave, the first four have been taken from a pair of engines with cylinders 28 in. and 53 in. in diameter respectively, and 33 in. stroke, while Figs. 5 and 6 show diagrams from a pair of engines with cylinders 29 in. and 55 in. in diameter, and a stroke of 33 in. Diagrams 1 and 2 were taken while working expansively with the link motion, while all the others are full power diagrams. Diagrams Figs. 1, 3, and 5 are from the small, and diagrams Figs. 2, 4, and 6 are from the large cylinders. In comparing these diagrams the system of coefficients introduced some time ago by Messrs. Elder has been adopted; the final pressure which would have existed in the large cylinder if the expansion had been continued to the end of the stroke, being ascertained by continuing the expansion curve and the mean effective pressure of steam throughout the stroke (considered as all acting on the large piston) being divided by the mean final pressure thus found to get the coefficient. For instance, referring to diagrams Figs. 1 and 2, it will be seen that the mean effective pressure in the small cylinder is 25.85 lb. per square inch at the top and 26.8 lb. at the bottom, the mean effective pressure being thus $\frac{25.85 + 26.8}{2} =$ 26.325 lb., which is equal to a mean effective pressure of 7.33 lb. per square inch on the large piston. In the large cylinder the mean effective pressure is at the top 8.85 lb., and at the bottom 8.825 lb., the mean being thus $\frac{8.85 + 8.825}{2} =$ 8.837 lb., which added to the 7.33 lb. from the high-pressure cylinder gives 8.837 + 7.33 = 16.167 lb. total mean effective pressure which is to be divided by final pressure in large cylinder to get the coefficient. In the case we are considering the final pressures in the low-pressure cylinder obtained by extending the expansion lines as we have explained, are 5 lb. at the top and 4.75 lb. at the bottom end, these values being measured from a zero line taken at 14.75 lb., per square inch below the atmospheric line. The mean final pressure is thus $\frac{5 + 4.75}{2} = 4.875$, and the coefficient of efficiency is $\frac{16.167}{4.875} = 3.32$, or, as it is more usually written (a multiplication of 100 being supposed, in order to get rid of the decimal point) 332. We have explained in detail the above mode of calculating coefficients of efficiency because it is far from being so widely known as it deserves to be. It gives an excellent measure of the amount of work derived from the use of a given quantity of steam, and we should like to see it universally used as a means of comparison by the builders of engines of all classes. We give below in a tabular form the various particulars referring to the indicator diagrams we engrave:

	Diagrams Figs. 1 and 2, working expansively.	Diagrams Figs. 3 and 4, full power.	Diagrams Figs. 5 and 6, full power.
Diameter of small cylinder	28 in.	28 in.	29 in.
Diameter of large cylinder	53 „	53 „	55 „
Stroke	33 „	33 „	33 „
Mean effective pressure at top of high-pressure cylinder	25.85 lb.	33.6 lb.	31.25 lb.
Mean effective pressure at bottom of high-pressure cylinder	26.80 „	34.4 „	32.45 „
Mean of mean effective pressures in high-pressure cylinder	26.325 „	34.0 „	31.85 „
Equivalent pressure in low-pressure cylinder	7.33 „	9.49 „	8.87 „
Mean effective pressure at top of low-pressure cylinder	8.85 „	10.85 „	10.975 „
Mean effective pressure at bottom of low-pressure cylinder	8.825 „	10.75 „	10.70 „
Mean of mean effective pressures in low-pressure cylinder	8.837 „	10.80 „	10.8375 „
Total mean effective pressure supposed to be all exerted in low-pressure cylinder	16.167 „	20.29 „	19.7075 „
Mean final pressure in low-pressure cylinder	4.875 „	6.375 „	5.875 „
Coefficient	332	318	335
Pressure of steam in boilers	57 lb.	60 lb.	57 lb.
Vacuum	28 in.	27½ in.	28 in.
Revolutions of engines per minute	60	72	68
Horse power developed in small cylinder	178.2 H.P.	249.7 H.P.	238.4 H.P.
Horse power developed in large cylinder	214.7 „	285.9 „	292.0 „
Total indicated horse power	392.9 „	535.6 „	530.4 „

The performances shown by the diagrams are all particularly good, and the coefficients exceedingly high, that from the full power diagrams, Figs. 5 and 6, being especially noticeable.

The type of marine engines we have described is that now exclusively made at the Hartlepool Iron Works, and we should mention that such engines are now being turned out by Messrs. Richardson at the rate of a pair per fortnight. The nominal horse power principally in demand ranges from 90 to 150, and the working pressure on the boilers from 65 to 80 lb. per square inch. Orders are already booked for these engines that will maintain the present rate of supply up to the middle of next year. Amongst vessels already fitted with these engines, we may mention the ss. Isa, 120 horse power; the Buckingham, the Thomas Parker, and the Chester, each 110 horse power; the Seaton, the Vendsyssel, the Stanley, the Farnley Hall, and the Oceano, each 100 horse power; and the McLeod, 90 horse power.

All parts of these engines are made to gauges and templates, so that any detail fits any engine of the same power, a system that secures the greatest possible speed and accuracy in construction, and which the present great demand for marine engines of about the same power enables to be advantageously carried out. Of the general design of the engines we illustrate we cannot speak too highly; it is exceedingly simple, and is altogether of such a character that while every attention has been paid to thorough efficiency, special manufacturing facilities have been provided for. In these days of keen competition, the latter is an important matter alike to the builder and the steam engine user, and it is only by paying special attention to it that really high class engines can be furnished at a moderate cost.

THE OVERLAND ROUTE TO INDIA.

TO THE EDITOR OF ENGINEERING.

SIR,—Your able leading article of the 18th August, 1871, I have read with very great interest and pleasure, particularly so, as I profess to be one of the pioneers for this really great work, and I consider it must be eventually throughout an overland route of continuous railway, running direct from London to Bombay (without a break) for about 5500 miles, and by which carriages could be run at a rate of 30 miles per hour average, or 720 miles per 24 hours, thus accomplishing the journey through from London to Bombay in less than eight days, without a change of carriage!

I have thoroughly and carefully calculated and estimated the time that would be required to construct this overland railway so as to be in complete working order, and believe, from my long practical experience, that ten years' work, with perseverance, would secure and accomplish this undertaking, which would be of immense importance to the British nation, in bringing our Indian possessions within access from England to Bombay in eight days for military, commercial, and general purposes and advantages. Calcutta could then be reached in ten days, and Madras in nine days, from England. China, Japan, and Australia (*viâ* Singapore), would be accessible in considerably less time, by the distances or mileages being run over by swift carriages and safe railways, a sea route completing the journey from Singapore to Northern Australia—say 3650 miles from England to Singapore by railway direct through, and a voyage of 2050 miles by swift steamers from Singapore to Perth (or one of the north-western ports of Australia), making a total journey of about 20¼ days, or 10,700 miles from England (through India) to Australia!

The proposed general route of the railway, in my opinion, should be by a shortened run of about 65 miles from London to Folkestone, then crossing the Channel by a triple arch railway submarine tunnel, 19 miles to Cape Grisnez, as already submitted by myself. From Cape Grisnez, lines of rails are complete, with a few additional loops required; onward through France, Switzerland, Prussia, and Austria, to Orsova, in Hungary.

From thence to Constantinople the railway will be in Turkish hands. Crossing the Bosphorus with an over bridge railway at high level, passing on to Aleppo, a distance of 1800 miles, through Turkey in Europe and Asia. From Aleppo to Bussorah the Euphrates Valley line, as projected, for several years past, by W. P. Andrews, C.E., would carry the railway 850 miles towards India. The next shortest route will be found to be that of a coast line of railway extending from Bussorah to Kurrachee, for about 1200 miles, running parallel, or nearly so, with the sea shore, crossing several rivers, which rivers' mouths will eventually form commercial ports, when trade and commerce is introduced, by the civilising progress of railways, through Persia and Belvochistan, now laying desert wastes. From Kurrachee to Hyderabad, the line of railway is complete, and a further extension to Ahmedahbad is in progress, and will, no doubt, be completed with all speed, so as to form an unbroken line from Kurrachee to Bombay, Calcutta, and Madras, thus making India accessible from England, or *viâ versâ*, in seven or eight days, by express trains.

I am, yours respectfully,

W. AUSTIN, C.E.

17, Bristol-terrace, Bermondsey-park, S.E.,
September 12, 1871.

THE RUSSIAN AND TURKISH NAVIES.—The following is a tabulated comparison of the Russian and Turkish navies:

	Russia.	Turkey.
Ironclads	24	13
Other steam vessels	166	97
Sailing vessels	29	53
Guns	2270	2283
Seamen and marines, including officers	64,021	34,000

BEETROOT SUGAR.—A meeting was held at Sleaford on Monday (Mr. C. H. Packe, chairman of the Great Northern Railway Company presiding) to make arrangements for commencing the manufacture of beetroot sugar in the neighbourhood. The promoters of the contemplated manufactory stipulate that they shall have the beetroot produce of 600 acres guaranteed to them annually for five years. An effort is also being made to establish a similar manufactory at Long Sutton. The success which has attended the operations of Mr. Duncan, at Lavenham, Suffolk, has stimulated this Lincolnshire movement.

MILITARY PROGRESS IN RUSSIA.—Two military facts of considerable weight (says the Berlin correspondent of the *Times*) are reported from Russia. The St. Petersburg War Office informs us, in an official order, that the number of breechloaders required for the entire army on a war footing has been completed at last, and that there is also an ample supply of cartridges on hand. The rifle adopted is an improved needle-gun, called, after the manufacturer, the Krinck pattern. The other event is the impending opening of the Brest-Minsk-Smolensk Railway, which establishes direct communication by steam between Moscow and Warsaw. Until now Poland had no railway connexion with the interior, except by way of St. Petersburg—a circumstance which made its tenure dependent upon the defence of a single line. The new railway, therefore, which will be opened on the 1st of October, supplies an urgent want, and that all the more effectively from its situation in the central provinces where no enemy can easily penetrate. The same correspondent states that the Russian and Turkish Governments have agreed to connect their Asiatic telegraphs. A wire will be laid down between Tiflis and the military post of St. Nicholas, on the Turkish frontier.

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CONTENTS.

	PAGE
The "Waterstaat" of Holland	169
Literature	169
Mikoy's Method of Constructing Foundations	170
Narrow Gauge Railways	171
Institution of Civil Engineers	172
Proposed Tunnel under the Clyde	172
The Manufacture of Wire	173
Notes from Paris	173
Bessemer's Heavy Ordnance	173
Foreign and Colonial Notes	174
Compound Marine Engines	175
Overland Route to India	176
The Rights of Inventors	177
The Iron Fields of La Meurthe	177
Screw and Rivet Manufacture	174
Ice Manufacture	179
The Mont Cenis Tunnel	180
Notes from the South-West	181
Notes from the North	181
Notes from Cleveland and the Northern Counties	181
Recent Patents	182
Air-Tight Stoppers	182

ENGINEERING.

FRIDAY, SEPTEMBER 15, 1871.

THE RIGHTS OF INVENTORS.

WE have before us the evidence received by the Select Committee appointed to examine into the much vexed subject of patent rights, and to report to the Government their opinions in order that assistance may be rendered in framing a modified legislation to protect alike the privileges of inventors and the public.

The committee has arrived at no conclusion save that a similar body should be appointed during the ensuing session to continue the investigation, but the evidence received already is important and will go far towards helping the question to a satisfactory issue.

Speaking broadly, the witnesses examined—and these included amongst their number those most entitled to offer an opinion—may be divided into three classes, those who wish to abolish the rights of inventors, those who wish to set very narrow limits to the privileges of patentees, and those who seek to extend the facilities for promoting inventive skill, and of increasing the probable chances of reward to inventors.

Foremost amongst the first-named class stands, of course, Mr. Macfie, who has long earned for himself an unenviable notoriety by his sweeping sentiments, and who, if possible, excelled himself in his ridiculous and unpractical suggestions before the committee. We have much difficulty in deciding what manner of man Mr. Macfie really is, whether he is merely ignorant of human nature, or a "smart" man of business; his opinions point to the former conclusion, their tendency to the latter. Thus, for example, we find him state, in reference to the acknowledgment of priority of invention, without any necessary substantial reward, "that it would give persons who are entitled to it the honour of priority, and gratify the impulses of well ordered minds to communicate what they believe will be beneficial to their fellows, while it would suit, in a way that patent monopolies do not, the case of amateurs, to whom valuable thoughts often occur." Also, it would suit in a way that patent monopolies do not, the case of manufacturers, such as Mr. Macfie, who could then benefit unchecked, by the results of inventive skill and patient investigation, supposing that the former were not chilled, and the latter annihilated by the course he proposes. Seriously, does Mr. Macfie believe in the existence of such "well ordered minds" as he described?—possibly. Mr. Ruskin has faith in the possibility of a rustic Arcadia. But then Mr. Ruskin is essentially a poet, and Mr. Macfie is a sugar refiner. Again, he says: "I speak for myself, and I know that what one man feels, almost every other man he meets with feels; a ribbon or a recognition from the Queen, that I had served the public, I would rather have than thousands in money; a working man having a certificate or a medal over his chimney-piece, in sight of his wife and family, would be a prouder, a better, and a happier man than if he was the mere recipient of money that had been levied on his fellows." And this proud consciousness, this happy feeling would be intensified by the reflection that such men as Mr. Macfie were developing his invention, giving it a high commercial value, and reaping rich results from what did not belong to them. But in the magnificence of his ideas, Mr. Macfie does not propose that inventors should be unrewarded—not at all. There should be a State grant to recompense inventive genius, and inventive genius should be classified into various orders of merit, the first of which should receive, say, 10,000*l.* as full payment, and the last but one, a bronze medal or its equivalent in money, say, 1*s.* 6*d.*, while in such very exceptional cases as that of Mr. Bessemer, 100,000*l.* might be paid, considering that that gentleman had already disbursed some 20,000*l.* in developing his discoveries. Who, on reading this and similar nonsense that occupies pages in the minutes of evidence, can accord to Mr. Macfie even the respect that is due to earnest motives?

M. Schneider, the managing partner in the great works of Creuzot, offered at least rational opinions to the committee, although his evidence was singularly damaged by the succeeding witnesses, Mr. Bessemer and Mr. Nasmyth. He opposed the granting of patents, not entirely, indeed, but still with so strong an opposition, that the measures he sketched out for testing the patentability of invention would be tantamount to prohibition. M. Schneider's ideas of invention are as peculiar, as, according to the evidence of Mr. Bessemer and Mr. Nasmyth, are his notions of patent right. During forty years of practical experience, he alleges that he has known only "a very limited number of cases in which an industrial invention belongs to any one in particular, represents a work of genius, and is at the same time a great service rendered to the public, and which would not have been the next day rendered by some one else."

In effect M. Schneider does not believe in invention, because almost everything is sure to be invented sooner or later. We cannot here follow M. Schneider's cumbrous definition of a real invention. But we may cite an illustration that he gives of what is *not* an invention. In 1840 he lacked at his works the means for making heavy forgings, and proceeded to England to see if any mechanical appliances existed there to meet his want. Before starting, however, his chief engineer submitted to him the designs for a steam hammer. Arrived in England, he met Mr. Nasmyth, who was then working out the same problem. M. Schneider pointed out defects to Nasmyth that existed in the latter gentleman's plans, returned to France, built a hammer after the design of his chief engineer, but took no patent, because if "he or his engineer had not invented it, it would have been invented, six months afterwards, by two, four, or ten people." Mr. Nasmyth, however, patented the identical hammer, and what Mr. Nasmyth says on the matter is worth recording. He states that he never saw M. Schneider in his life, and that M. Bourden, that gentleman's engineer, acknowledged that the patterns of the Creuzot hammer were obtained from the drawings they saw at Patricroft during Mr. Nasmyth's absence. This damaging testimony is somewhat beside the question, unless it be taken as an illustration of M. Schneider's peculiar views on the subject generally, which may lead him to look upon the results of invention as common property, in which no one can have any priority, because some one else would subsequently have followed in the same steps.

Sir William Armstrong takes another view of the question; he considers patents obstructive and obnoxious; he has been foiled in developing many important ideas, because "vexatious" patents have stood in his way; he would annul the patent laws, but he would have inventors benefitted by State generosity. Or, if patent laws are to exist, they should be so far modified as to exact so strict an investigation that very few petitions would be granted. Sir William Armstrong was, however, upon the whole, the fairest opponent to rights of inventors that was examined by the committee.

It is difficult to understand how two opinions can exist upon the question of individual rights in invention. It is true that some interests may point towards the abolition of protection, because were there no security for inventors, wholesale appropriation could be effected with impunity, to the infinite advantage of capitalists. The most eager advocates for doing away with these first rights of inventors freely admit the exclusive proprietorship in creation of art and literature. As M. Schneider puts it, the artistic or literary production is "the soul, the spirit, the personality of the man" himself. But where lies the difference? The specialty of thought and power that makes this man an artist or that a poet, belong only to a different field of genius out of which mechanical invention springs. The incentives to cultivate each are the same—reputation and wealth, for there are few men, even the least businesslike and the least worldly, who would be so foolish as to look forward as the result of their life's work to a certificate on parchment and a medal of bronze. The desire to acquire money, which is power, is a characteristic so universal, that the exception proves the rule, and were the means to attain this end taken away, invention would languish, and the unwearying patience and work needed to develop it would disappear. Had there been no protection, would Mr. Bessemer have devoted years of his life, and so many thousand pounds to the perfecting a discovery which has been one of the greatest and most useful ever made? He says, certainly not, for he could have found more profitable employment for his abilities. And even supposing that he had done so, and that he had given an unappreciative public the benefit without gaining any return, who would have profited? The manufacturers and not the world at large. Or suppose that Mr. Macfie could (the object so dear to him being accomplished), see without cost to himself any invention that should revolutionise the special branch of commerce in which he is engaged, it is not probable that the price of sugar would be reduced, only that Mr. Macfie would become richer, while the inventor would have no benefit whatever, because he would cease to have an ownership in his production.

That the patent law requires modification no one can deny, and the alteration most urgently required is one that would give greater facilities to inventors. It is true that there exist many frivolous and vexatious patents, but it is impossible that all these should ever be eradicated, even by the most careful examination.

Just in the same way there exist gross abuses of the Patent Office, on the part of inventive pirates who levy black-mail on honest inventors. But how small a percentage do these form of the whole, how slight the evil they create compared with the vast benefit rendered by protection. There was never yet any institution free from weakness, not able to be abused, and the object of any modification of the patent laws should be to reduce these evils to the utmost, whilst affording inventors all security, and especially protecting them from the attempts now being so diligently made to destroy the rights of proprietorship by those who are seeking to establish a Commune at the Patent Office.

THE IRON FIELDS OF LA MEURTHE.

THE attention of metallurgists, and indeed of all those who are interested in the iron industries of France, is turned at the present time to the study of the mineral districts of the Meurthe and the Moselle. This rich ferruginous basin, the utilisation of which has only assumed importance during the past 25 years, excited the cupidity of victorious Germany, and the new frontier has been traced upon the geological map. The greater part of the mines and iron works have been wrested from France, as we have already stated, when we published some statistics on the subject in ENGINEERING for the 25th of August. We propose, now, to consider the conditions of the department of La Meurthe, which have been for the most part left to France by the treaty of peace, and which appear to

demand just now an active development, and to promise a most prosperous future.

We may borrow many valuable statistics from a geological and practical work recently published by M. A. Braconnier, engineer of mines in the department.

The iron ores actually extracted in La Meurthe belong exclusively to the oolitic ferruginous formation. This formation consists of numerous beds of clay of greater or less thickness, and more or less sandy or calcareous, commonly called *marne*, and oolitic ore alternating. It rests upon the sandstone, and lies covered with gray or blue *marne*, itself overlaid by the calcareous beds of the inferior oolite.

The geological plan of M. Levallois, inspector-general of mines, shows the space occupied by the inferior oolite, and fixes, with a few exceptions, all the parts regularly stratified with the oolitic ferruginous formation. By the aid of this map one is able to solve a great number of problems, amongst others the following: to value the superficial extent that the mineral beds occupy within the boundaries of a concession; to determine the most suitable situation for the opening of a shaft or of galleries; to ascertain the existence of faults; to determine the general slope of the beds.

The ferruginous formation of this district shows a slight general fall towards the west. It extends in the western district beneath a vast continuous plateau, is twice cut by the Moselle, which has formed a number of secondary valleys.

Towards the east on the right bank of La Meurthe, then under the right bank of the Moselle, the same formation is found beneath a certain number of isolated plateaux of small dimensions. These are without doubt the débris of the vast plain which at an early period formed towards the east the extension of the western plateau, and which has been broken up and disjointed by the powerful action of erosion.

The discovery of the iron ores in the department of La Meurthe appears to date from 1835. This discovery was not due to chance. Indeed, the existence of furnace slag in considerable masses along the valley of the Haute-Moselle, the presence of ore in heaps of rubbish along the cuttings of high roads, the distinctness of true outcroppings below certain escarpments, the works for seeking and storing water, even the denominations of several villages would infallibly have one day attracted the attention of the industrial world.

The first works were commenced in 1835 upon a well-marked outcrop, and the first blast furnace was built in 1837. During the few following years, discoveries of the ore increased rapidly. But although the formation was well known to exist under the lower oolite, almost throughout the length and breadth of the department of La Meurthe, it was necessary to ascertain by the help of shafts and galleries the exact disposition of the strata. The observations made upon the outcroppings and the broken fragments of ore could easily lead to grave miscalculation on the number, the thickness, and the quality of the beds of mineral; an example of this kind presented itself in the department of the Moselle at the works of Novéant-Basse.

The great development that has taken place during the last twenty-five years in the working of these mineral deposits had the result at first of creating the railways from Paris to Metz and to Strasbourg, the canal from the Marne to the Rhine, and that of the collieries of the Sarre, and afterwards the successive developments introduced into the processes of manufacture of cast and wrought iron.

At first the workings were conducted where there existed facilities of communication, without any regard to the conditions of the richness and thickness of the veins; in later times the reverse holds good, and to day we see the laying out of economical ways of communication preceded and determined by a precise investigation of the most advantageous deposits.

The first Table gives the statistics of the development of working for the year, up to the 1st of January, 1870.

The total minerals extracted up to the end of 1869 amounted to 1,619,867 tons. If we add to the list the old mines of the Chavigny group, and some other mines and various works not included in the Table because they do not find a place in the concessions, we shall find that there has been extracted in gross in the department of La Meurthe, up to the 1st January, 1870, 2,097,080 tons of ore, and that the work of 1869 is nearly one-fifth of the whole. These minerals supply not only the blast furnaces of the department, but also

Number.	Names of Concession.	Dates of Decrees of Concession.	Total area in acres.	Mineral extracted in tons.
			acres.	tons.
1	Champigneulles ...	August 5, 1848 ...	962	21,260
2	Chavigny	June 13, 1856 ...	839	7,355
3	Marbache	January 16, 1858 ...	1325	18,121
4	Frouard	March 10, 1858 ...	1667	16,577
5	Bouxieres-aux-Dames	August 16, 1859 ...	725	15,000
6	La Voiletriche	Sept. 26, 1859 ...	768	
7	Liverdun	March 17, 1860 ...	932	5,805
8	Hazotte	April 28, 1860 ...	933	16,576
9	Pompey	February 2, 1861...	286	1,413
10	L'Avante-Garde ...	May 23, 1863 ...	624	63,576
11	Buthegnemont	August 17, 1864 ...	682	4,509
12	Boudonville	" ...	970	77,197
13	Maxéville	" ...	666	38,660
14	Croisette-Liverdun ...	July 21, 1866 ...	839	24,934
15	Vandœuvre	January 9, 1867 ...	397	
16	Houdemonte	" ...	544	
17	Custines	August 16, 1867 ...	454	
18	Laxou	August 31, 1867 ...	600	53,453
19	Lay-St.-Christophe ...	Dec. 21, 1867 ...	452	370
20	St. Geneviève	March 14, 1868 ...	440	
21	Le Fond de Monvaux	February 10, 1869	644	
22	La Grande Goutte ...	" ...	536	
23	Le Bois du Four ...	June 25, 1869 ...	367	5,796
24	Le Montet	August 6, 1869 ...	824	

a large number of others more or less distant. The Table subjoined indicates the distribution of the minerals delivered in 1869 from the mines of the department of La Meurthe:

Names of districts supplied.	Number of tons consumed.
Meurthe	273,963
Haute-Marne	13,464
Bas-Rhin	676
Nord	11,918
Moselle	68,917
Prussia and Bavaria ...	51,273
Meuse and Marne	18,225
Belgium	386
Total	438,822

The selling price of the oolite ore, loaded on barges or wagons, varied in 1869 according to the quality, from 3.15 francs to 4.50 francs per ton, or an average of 3.89 francs. The total quantity consumed in 1869 represented a value of 1,711,914 francs.

The mineral is composed of small grains, which are generally about the size of a pin's head, and which are bound by an argillaceous or calcareous cement. The grains are sometimes spherical, sometimes irregular, and their colour varies from a brownish yellow to black; they have sometimes a reddish and rarely a bluish tinge. The microscope shows that they are composed of concentric layers.

The colour of the gangue is generally red or reddish yellow; it is sometimes grey, greenish yellow, yellow, or blue. Sometimes it is spread in a uniform manner, sometimes it is in flattened patches, and many regular and stratified bands.

The oolites are composed, for the most part, of peroxide of iron, combined with alumina, with silica, and with magnesia. They enclose abundant fossil remains, the greater part being shells of marine molluscs; fragments of wood are also encountered, as well as the vertebræ and the bones and teeth of the great saurians.

Pulverised and worked, the minerals leave behind them a rich residue. But this process of concentration, which was practically introduced, has been abandoned on account of the loss that is unavoidable, and the inconvenience that it presents in delivering the ores in a pulverised condition.

Without going into a detailed description of the analysis of the strata in the different concessions, we may select, as an example, those of the concessions of Croisette and Liverdun:

ft.	in.	
82	3	various earths.
2	5	mixture of marne and minerals.
2	6	yellow ore, mixed with brown, aluminous, containing less than 30 per cent.
4	11	marne.
2	11	yellow ore, with an excess of lime, containing from 30 to 35 per cent. of iron.
4	2	marne.
1	7	yellow greenish and brownish yellow ores, with numerous veins of green marne, aluminous, containing 30 per cent of iron.
3	10	similar ore.
0	11	marne.
0	11	yellow and chocolate ore, numerous veins and patches of bluish marne, aluminous, containing 30 per cent.
5	11	marne.
1	7	Reddish ore, aluminous, containing more than 35 per cent.

We may now give one Table of analyses of the oolitic ores which show the chemical nature of the hydro-oxides:

Name of the Concession.		Loss by fire in 1000 parts.	Silica.	Phosphoric acid.	Sulphuric acid.	Peroxide of iron.	Alumina.	Lime.	Magnesia.	Peroxide of manganese.	Metallic iron.	Metallic iron in 1000 parts of calcined ore.
Croisette	Liverdun	177	216	2.6	1.3	401	131	61	5	...	281	341
Liverdun	...	172	142	0.6	trace	481	102	79	21	...	337	407
...	...	139	190	0.3	trace	467	149	27	23	...	327	388
...	...	168	191	trace	trace	477	113	57	17	...	334	398
...	...	149	235	trace	trace	318	214	57	24	...	223	263
...	...	200	78	2.3	trace	265	100	293	"	...	180	260
...	...	232	85	4.6	trace	570	127	183	trace	...	259	359
...	...	161	114	0.6	0	507	109	13	16	...	416	498
...	...	165	134	0.8	trace	461	172	51	25	...	310	378
...	...	184	140	0.2	trace	472	186	32	13	...	330	404

We have said enough to show that France possesses in the oolitic strata of La Meurthe an immense supply of minerals of good quality, easy to work, and to reduce, since it is sufficient to combine in the furnace, the silicious with calcareous ores. The blast furnaces established in the district are all on the high road to prosperity; they obtain fuel and labour at a low price; transport is cheap, both of railway and canal; the market for the products is insured. The sudden separation of a large part of the mineral basin, and the works that it supplies, is giving a new impetus to the spirit of enterprise in the department of La Meurthe, and already we hear reports of important business combinations for the development of the district at various points, the construction of new furnaces, and the erection of new rolling mills.

This last work above all will be the most advantageous, since the annexation of Alsace and Lorraine leaves little to France but the works in the department of La Meurthe.

SCREW AND RIVET MANUFACTURE.

Birmingham abounds in screw and rivet manufactures. Out of the numbers we may briefly describe the works of Messrs. Nettlefold and Chamberlain, where their patent process of manufacture is carried on. Besides their screwing works in Broad-street, they have also other establishments in another part of the town, and wire-drawing works at Smethwick, where they manufacture wire for telegraph and other purposes besides what they employ at their screw works. The screws manufactured by the firm are principally wood screws, but other threads are also cut, and they manufacture a quantity of screws for stove work and for reaping machines, as well as for other special purposes. The rivets made here are chiefly those adapted for light work, such as are employed by tinmen and coopers, and weighing from a few ounces to about 16 lb. per thousand. Up to a certain point the mode of manufacture of rivets and screws is similar according to the process here employed. The first part of the operation for both classes of work is to cut the wire into the proper lengths, and to form the head. This, in the case of small work, is all done by one machine, and at one operation. Where comparatively thin wire is employed, the coil is simply hung over a wire attached at one end of the machine, one end being placed between the jaws of a feeder, but where heavier wire is employed it is necessary to pass it through a straightener before allowing it to enter the machine. The feeder consists of two jaws, which

close as they move forward, gripping the wire, and carrying it into the machine, but separating as they move backwards, preparatory to making a second bite at the wire. The proper adjustment of this feeder is a matter of no small importance, depending, firstly, upon the required length of the screw or rivet; and, secondly, upon the size and thickness of head required. The character of, and consequently the amount of metal required for, the heads of screws, especially those employed for ecclesiastical ornaments and other fancy work, varies so much that no especial rule can be laid down for guidance as to the additional length of wire that must be allowed for the purpose, and the proper setting of the feed motion of the machine is therefore a matter which experience alone can properly regulate. The machine having been properly adjusted for feed motion, and suitable dies inserted for the formation of the head of the rivet or screw, it is set in motion; a crank action causes the feeder to draw in the wire, with a proper proportion of excess wire for the formation of the head projecting in front. The jaws of the feeder now hold the wire rigidly whilst an eccentric action projects the head die forward from the opposite direction, stamping, or rather squeezing the projecting wire in a head of the required shape and form at one operation. This done a cutter working sideways from the machine severs off the now finished rivet, or screw stock, as the case may be. Another revolution of the machine causes a second rivet to be thrown out; and this goes on incessantly so long as the roll of wire lasts, the operation being perfectly automatic when once set in motion, and requiring but little attendance, so that one person is enabled to overlook several machines. Besides these horizontal machines, which will work with wire up to about ½ in. in thickness, there is also at these works a vertical, or as it is there called, an "upright" machine, which will take wire of a much greater thickness. For this the wire requires to be first cut into proper lengths by a suitable machine of simple construction. The machine consists of a bed-plate, on which is a receptacle for the lower die or holder. On either side of this there is an upright, between which works a stamper in a suitable guide piece, at the bottom of which is fitted the upper die for forming the head of the rivet, and motion is given to it by an eccentric revolving on a shaft above, and which is driven direct by a strap from the overhead motion shaft. It is fed by hand. In both these machines the heads are made without heating the iron. The heads to which we have hitherto been referring, so far as screws are concerned, are those which are round, and flat at the top, to be afterwards cut across for screw-drivers. Many screws, however, require to be made square-headed, for spanners, and these are generally forged by hand, but however neatly they may be made, it will always be found that there is a certain degree of irregularity in their shape, which renders it necessary to pass them afterwards through a shaping machine. Besides the great expense of this, it is found that the heating and cooling of the iron, during the forging of the head, reduces its strength, and that the heads of such bolts will sometimes give way when subjected to a severe strain. The intelligent foreman of these works is just now perfecting a machine for pressing out square heads to bolts, whilst the iron is in a cold state, by which, not only will the work be done much cheaper, but the necessity for subsequent shaping, and the depreciation of the metal, above referred to, will be avoided. From specimens which were shown to us, there would appear to be very little doubt but that this great object has now been successfully accomplished. As, however, the machine has not yet been patented, we are not at liberty at present to give any further details concerning it, or to state more definitely how the desired end is effected. The screw stocks having now been completed, the next process is to smooth down the heads, and to give them the proper size and form. The machine for this consists of a revolving holder, into which the end of the stock is firmly fixed, so that the head will revolve between two cutters shaped to cut it to the proper form. As soon as the machine is set in motion the attendant draws up a lever which causes the cutters to close upon either side of the screw head. These, however, are firmly set so that they will not approach one another beyond a certain point, otherwise this operation would have to be very carefully effected, and the result tested with callipers; and even then, with the greatest care, the screw heads could not be so evenly made as they now are by these machines. After this, the stocks are placed into a hopper attached to another machine, from which, by a self-acting motion, they are caused to slide down a slotted incline, at the bottom of which is a revolving vertical barrel, with circular cuts at intervals down its side; into these cuts the screw stocks fall one by one, with their heads projecting above the top of the barrel. They are then carried round beneath a small circular saw which cuts the nick in the head for the screwdriver, after which the stock is thrown out of the machine and carried away to receive the final operation of screwing. The screwing machines—which are worked exclusively by women and girls—require great accuracy in their adjustment, but when once properly set, it is impossible that there can be any deviation in the thickness of the screws cut. The cutter consists of two parts, a die, against which the screw revolves, and a cutter which is pressed by a lever against the opposite side of the screw; and these are first so set that they cannot approach within the proper distance of one another. The head of the screw is first fixed into a mandril head, where a driver point enters the nick, and it is further firmly held in position by a set screw. Of course a good deal of knack is required in this branch of the manufacture to get the cutter always into the trough of the screw, and so as not to cut the thread; but the greatest nicety—which is only acquired by great practice—is required when the screws are gimlet pointed. Of course on this class of work the women are all paid by the piece; and whilst some will only earn about 8s. a week, others doing precisely the same kind of work will earn as much as 18s. or 20s. a week. The packing of screws in paper is all done by hand, and with the greatest rapidity, the screws being put down side by side, alternate head and tail, by the two hands working together, each placing a screw with the head outwards, and rising row upon row until the required number—generally a gross—is completed. They are then tied up and labelled, and are then ready for the market. It may be here remarked that the breaking off of part of the heads of wood screws, which not unusually occurs, is owing generally not to any error in making the screws, as might naturally be supposed, but more often in consequence of the wire having received a twist in the operation of drawing. This causes a strain in the fibres of the metal, which too often cracks open during the operation of gathering in the metal in forming the head.

ICE MANUFACTURE.

ON a recent visit to Auteuil we passed through an interesting establishment, directed by M. Tellier, the inventor of a machine for the manufacture of ice, and including various modifications of this invention; the application of which is daily extending.

The system of M. Tellier is based on the evaporation of pyroligneous ether. The distillation of wood gives among other products spirits of wood or pyroligneous alcohol $C^2 H^4 O^2$. It is a colourless liquid, which boils at 149° and gives out a pungent odour. Its chemical properties are very similar to those of alcohol ($C^4 H^6 O^2$); thus the latter submitted to the action of sulphuric acid loses an equivalent of water, and transforms itself into ether ($C^4 H^5 O$) whilst the pyroligneous alcohol treated by the sulphuric acid is converted into ether ($C^2 H^3 O$). This ether is much more volatile than ordinary ether. At atmospheric pressure it volatilises at 22° below zero. It is thus always in a state of vapour at ordinary temperature, and it is only possible to keep it in a liquid state under considerable pressure. M. Tellier always keeps on hand a sufficient stock of the material held in cast-iron vessels, strong enough to resist a pressure of ten atmospheres. These vessels are provided with a small cock carefully fitted and packed to avoid any chance of escape of the ether. When the tap is opened the ether passes into the atmosphere, vaporising instantly; and consequently absorbing a large quantity of heat. It is easy to perceive that such a vessel charged with pyroligneous ether, constitutes by itself a powerful reservoir of cold, and it is very simple if it is not desired to recover the vaporised ether, to manufacture the ice instantly, and M. Tellier, indeed, has proposed this method of procuring small quantities of ice, so precious in surgical operations, especially in time of war.

But in the economical manufacture of ice and in the industrial production of low temperatures the condensation of the ether is a matter of necessity for the purpose of employing it again, and this is effected by submitting the vapour to a strong pressure. The action of the apparatus is then based on the constant circulation of the same mass of ether, alternately vaporised by simple escape, and condensed by compression. A wooden vessel is employed protected against heating from the air by means of straw and felt packing in which can be placed a liquid able to resist a sufficiently low temperature without freezing. For this purpose a solution of chloride of calcium in water is generally used. In this wooden back is arranged a series of tubes surrounded by a cylindrical envelope. A rotary pump draws the liquid from the back forcing it through the tubes into the vessel again, thus insuring a constant circulation, and maintaining an equal temperature throughout the liquid into which are plunged the moulds containing fresh water. The ether contained in a vertical cylindrical vessel, escapes in vapour into the envelope containing the tubes, and spreading itself over the great surface presented by the combination of tubes, and absorbs the heat. A pump worked by an engine collects the vapour at the other end of the cylindrical envelope, and forces it back again into the vertical vessel before mentioned, so that the ether level is maintained almost constant. All the pipes are closely covered with bad conducting materials except some parts which remain covered with ice produced by the deposit of humidity in the atmosphere, and which serve to assist the workmen charged with the management of the apparatus in ascertaining constantly the performance of the machine. The pump is enclosed in a double envelope, and a current of water constantly circulates in the annular space around the body of the pump to remove the heat generated by the compression of the ether vapour. Every precaution is taken to prevent the escape of the gas which would at once be a source of loss, and a cause of danger on account of its inflammability. All the joints are made in caoutchouc, this substance resisting well the action of ether. The cocks have screw ends terminating in an acute cone, and are seated on lead packing. The pump piston is fitted with metallic packing rings, the valves are arranged in such a manner as to reduce to a minimum inconvenient spaces; the packing of the piston rod is composed of two rings between which is maintained a constant stream of oil. A reservoir of oil is fixed against the side of the vertical boiler; it conveys a regular and fine stream into the packing; which, penetrating into the body of the pump, passes with the ether into the vessels. The greater part of it is afterwards separated by passing the mixture in the vessel through a strainer placed in the reservoir. But despite all these precautions the consumption of oil is very considerable.

The pressure in the boiler is maintained at 12.8 lb. per square inch, and the temperature of the solution of chloride of calcium is 14° above zero (Fahr.). The ice produced is white with an irregular crystallisation.

For producing low temperatures for industrial purposes, it is sufficient to effect the circulation of the liquid in the back through the pipes passing it constantly through to re-cool it. It is by this means during the most elevated heat of this summer, we have visited, with M. Tellier, chambers where he maintained the temperature at 28½°.

The process is largely employed in many industries, such as breweries, stearine candle factories, in the manufacture of nitro-glycerine, in the crystallisation of salts of soda, in the preservation of meat. In this last application, M. Tellier has been very successful. During the siege he presented to the Academy of Sciences pieces of meat which had been preserved for fifteen months. The samples gave much satisfaction, but the situation was so special, that fresh experiments will have to be conducted. The following is a sketch of the process: The meat is placed in an iron receptacle which can be closed at the upper end; it is deposited in a wooden back in which the freezing mixture is made to circulate. The air is then drawn out from the vessel, but as it is impossible to obtain a perfect vacuum, to draw the last traces of water from the meat, a current of carbonic acid is passed over it for some time. This it is easy to absorb with a little lime, and a vacuum almost perfect is obtained.

M. Tellier is now developing a project on a grand scale for the importation of meat from Australia. A factory would be established close to the slaughter

house, where the meat would be submitted to the process already described, and ships fitted up with refrigerating machines would transport the results to Europe.

THE MONT CENIS TUNNEL.

To the Editor of Engineering.

Sir,—A prolonged absence from Turin has compelled me to interrupt the series of letters on the Mont Cenis Tunnel which I have commenced in your estimable journal. I am happy to say that I shall now again have leisure to send you my essays as regularly as possible.

Since my last appeared in Engineering, M. Sommeiller, the chief engineer of the Mont Cenis Tunnel, the inventor of the perforating machinery, and of the application of compressed air as a motive power for working it, has met with an unexpected and untimely end. As a man, he was upright, loyal, open, and cordial. As an engineer, his science could only be equalled and has perhaps never been surpassed.

A narrator of what has been accomplished by the genius of this great and good man, even were he not a member of the technical staff engaged on the Mont Cenis Tunnel Works, could not omit to mention this sad event.

The memory of Sommeiller needs no further commentary.

"Alpes exarabat gloriam ejus"

Turin. F. Kossuth.

Having in my last letter given a general idea of the disposition of the external works and workshops at Bardonnèche, I need not describe those at Modane which are in their principal parts similar. There is only one essential difference between the two arising from the difference in the local conditions: At Bardonnèche the opening of the tunnel is at the same level (or nearly) as the workshops, whereas, at Modane, it is at a considerable height above them. An inclined plane was therefore established at Modane, on which everything was conveyed up to the mouth of the tunnel from the workshops and working yards down below.

The motive power in working this inclined plane is the weight of a mass of water confined in receivers adapted for the purpose, which travel up and down the incline, and pull up with their weight (properly regulated by the admission of a greater or smaller quantity of water) the cars loaded with the materials, tools, and implements, &c., required for the tunnelling.

Mechanical Appliances in the Mont Cenis Tunnel.

The mechanical appliances employed in the Mont Cenis Tunnel consist of two separate parts.

1. The plant outside the tunnel.

2. The mechanical means employed in the tunnel for the excavation of the rock itself.

The former may be subdivided into—

(a) Ventilation.

(b) Transmission of motive power.

The latter consists of—

(a) The perforation by the machinery invented by M. Sommeiller, of the holes for blasting.

(b) Blasting.

(c) Clearing away of the excavated rock.

The requirement of special ventilation and of special excavating appliances, as well as the absolute necessity of a particular kind of motive power, is self-evident when the length of the Mont Cenis Tunnel is taken into consideration.

All who ever have carried on mining are aware of the importance and difficulty of ventilation, when the length of the tunnel becomes excessive. It may be interesting to offer a few remarks on this subject, having a special reference to the means employed in the work we are now describing.

The causes of the vitiation of air in tunnels* are the blasting of the mines and consequent explosion of gunpowder, the combustion of lamps, and the respiration of the workmen.

One pound of gunpowder exploding produces

0.49 lb. carbonic acid gas
0.10 „ oxygen
0.41 „ sulphide of potash

Now, as atmospheric air fit for respiration only can contain about 5 per cent. of carbonic acid gas, the explosion of one pound of gunpowder is capable of vitiating $\frac{0.49}{0.005}$ lb., that is 100 lb. of air, or speaking in volume instead of weight, 45 cubic yards of air, one cube yard of air weighing in round numbers 2.18 lb.

However, the carbonic acid is not the only gas produced calculated to render air unfit for respiration.

The proportion of oxygen in the air is nearly permanent, being 79 per cent., and if this percentage is increased air becomes unfit for breathing.

Further, sulphide of potash considerably vitiates air, and hence we may safely admit that 1 lb. of burnt gunpowder impregnates 148½ cubic yards of air.

Now practice has shown that in order to render air fit for respiration in a place where there is no current, from 10 to 13 cubic yards of fresh air per hour have to be introduced for every man employed.

Further, to replace the air consumed by the combustion of each miner's lamp, about 9 cubic yards of air are wanted per hour.

Let us now consider the quantity of air which would have to be consumed for 130 cubic yards of excavated material, excavation being carried on with ordinary means. Practice has shown that in order to excavate 130 cubic yards of hard rock, 400 blasts are required, and 176 lb. of gunpowder are consumed; further, to make 400 blasts 214 days' work are required, calculating a day's work as 12 hours; and, again, as in a gallery, masons, carpenters, &c., are wanted, we may add 120 days' work of 12 hours each.

Supposing, then, that 130 cubic yards of rock should be extracted in 24 hours; during this period of time we shall have to introduce:

	cubic yards.
For 107 miners, and 60 other workmen ...	62,424
About 83 oil lamps	18,238
To replace the air vitiated by the explosion of 176 lb. of gunpowder	26,160
For every 130 cubic yards of rock extracted	96,822

cubic yards of fresh air is required.

Now the section of the Tunnel of the Alps having 71¾ square yards, in order to advance *one* yard in length in the excavation, if ordinary means were used, about 53,400 cube yards of air would be consumed, and as the total length of the tunnel is 13,364 yards, to perforate it entirely over 710,000,000 cubic yards of air would be consumed.

Further, the temperature of air must be kept within certain limits to maintain the workmen in a proper condition.

We know that approximately for every 98 ft. of depth attained from the surface of the earth temperature increases 1.80°. The height of the mountain under which the Mont Cenis Tunnel passes being 5285 ft., the temperature in the tunnel would be 127.40°, to which we should further add the temperature produced by the burning of gunpowder and the combustion of lamps, we may safely assume the temperature to be 140°.

These considerations will clearly show the absolute necessity of a very efficient system of ventilation being adopted, without which the execution of the work would have been utterly impossible; further, the ordinary means used by miners for ventilation were not sufficient, nor indeed were they applicable.

These ordinary means consist of fans which are placed at the mouth of the tunnel, which is divided into an upper and lower chamber, in order to allow the vitiated and more heated air to be drawn along the upper part, and to be replaced by pure air along the lower part of the gallery.

But in tunnels of such excessive length, not only hours, but days would be required before pure air would arrive to the headings, even were the causes of the vitiation of air not permanent.

Hence it was necessary to carry along with great velocity, and compassed in a small volume, a sufficient quantity of air precisely to those parts of the tunnel where the works were concentrated, and the permanent causes of the vitiation of the air existed; or, to speak more correctly, it was indispensable to combine the two means of ventilation.

The exhausting machinery at Bardonnèche consists of a tangential turbine, moved by a column of water 65.7 in. in height. The theoretical velocity is 87 revolutions per minute, and about 40 cube yards of air can be extracted with it per second.

At Modane the exhausting machinery consists of an ordinary pump. As regards the machinery with which compressed air was sent along to the heading in the tunnel, they were the same as those with which the motive power was produced, and will be described presently; in fact, the introduction of compressed air in the heading was effected by opening cocks along the tubes which carried the motive power. There certainly was a great inconvenience in using compressed air in the ventilation, owing to the consequent loss of useful work. Let us form an idea of this loss by estimating the quantity of work which can be performed by a cubic metre of compressed air.

$\int p\,d\,v$ represents the work which gas produces in expansion. If we suppose that the gas in expanding absorbs so much heat from the surrounding gas, that its temperature becomes equal to that of the latter, the equation of elasticity of the air will be $p\,v = \mathrm{R}\,t = \cos.\,t$, and hence:

$$\int p\,d\,v = \int \mathrm{R}\,t\,\frac{d\,v}{v} = \mathrm{R}\,t\int\frac{d\,v}{v} = \mathrm{R}\,t\,\log v + \cos.\,t,$$

will express the work done by the gas through expansion.

And as its temperature remains constant, Mariotte's law receives an application: the compressed air being supposed by us to expand from a pressure of six atmospheres to that of air, its volume from v_1 will pass to v_0, so that $v_0 = 6v_1$, and hence the work which the air through its expansion is capable of producing, will be given by the expression:

$$\int_{v_1}^{v_0} r\,d\,v = \mathrm{R}\,t\,\log\frac{v_0}{v_1} = \mathrm{R}\,t\log 6,$$

or passing from the Naperian to decimal logarithms,

$$\mathrm{R}\,t\,\log 6 \times 2.30;$$

the constant for air is R=29, 27.

The temperature, $t = x + t = 273 + t$, which we will suppose 300° centigrade, and completing the calculation we find 15,718 kilogrammetres as the result.

This calculation refers to 1 kilog. of compressed air, and 1 metre cube of air weighing 1.3 kilog., according to Mariotte's law, the cubic metre of compressed air expanding from the pressure of six atmospheres down to that of one atmosphere, its volume will become 6 metres cube or nearly, and the weight will be 7.80 kilog; thus one metre cube of air compressed to six atmospheres, and expanding down to one atmosphere, developes useful work equivalent to 15,718 kilogrammetres × 7.8 = 122,600 kilogrammetres.

This quantity of work lost by the application of one metre cube of air compressed to six atmospheres for ventilation, is certainly enormous. However, the loss had to be submitted to, in order to make respiration, and continual work at the heading possible.

Francis Kossuth, C.E.,
Royal Commissioner for Railways in Italy

* J. Fettarappa, C.E.

The New 16-Pounder.—Tuesday morning six guns, carefully packed in jute and wrappers, and jealously guarded from the vulgar gaze, were held in readiness at the Royal Arsenal to be despatched to Aldershot, there to be the armament of the H Battery of Field Artillery, and as experimental weapons to take part in the autumn manœuvres. They are 16-pounders, weighing 12 cwt., and rifled in three shallow grooves similar to the 9-pounders. The shape, however, differs from that of the latter, there being no swell at the muzzle; the sighting, too, is different, occupying a central position on each of the trunnions. A cleverly devised arrangement for securing the screw which tightens the rear sight is observable on these guns. In lieu of the old chain, which frequently became detached, there is an arm upon the head of the screw, which catches against a button on the surface of the breech as it unwinds itself, and prevents the screw from making more revolutions than are actually requisite. The carriages, limbers, and ammunition wagons for these guns have undergone very important modifications. Similar weights to those of the 9-pounders have been retained. But the number of rounds has necessarily been reduced from 120 to 100. They are disposed as follows: six boxes on the wagon and two on the limber, containing each 12 rounds, making an aggregate of 96. The remaining four repose in two shallow boxes beside the gun upon the carriage itself, and upon these boxes, when closed, seats are arranged for two additional men. The shells are packed tight, with a stuffing around them of tow—a wise provision to prevent their jolting. The old covers, with mouldings to rest upon the extremities of the shells, seldom fitted close. A narrow chest for fuses finds room for itself between the two boxes on the wagon limber. A contrivance beneath the axle bed of the gun, only approachable by a considerable amount of manipulation—involving a loss of time scarcely, we imagine, to be advisable—contains tubes. Such is the new 16-pounder. That it is a weapon of terrible efficiency none can doubt. Experiments at Shoeburyness have established its reputation, as the Americans say of their Gatling, "beyond a 'peradventure." But we question whether its supericrity in point of range and weight of projectile counterbalances the extra labour which is involved in its transport. The ensuing month will afford interesting information on this point. We understand, however, that a third steel and iron field gun is about to be experimented on—a 25-pounder, weighing 21 cwt.—*Standard*.

NOTES FROM THE SOUTH-WEST.

Newport (Alexandra) Dock.—The Duchess of Beaufort, accompanied by Lady Blanche Somerset and Lord Henry Somerset, has visited the works of the Newport (Alexandra) Dock Company, upon which nearly 600 men are now employed. The party were conducted over the works by Mr. Griffiths, one of the contractors; Mr. Williams of the engineer department, was also present. The east wall appears a stupendous structure, the stonework having now reached at the northern end the full height, with the exception of the coping; in some places the height is 54 ft. while the foundations are 18 ft. wide.

Trade at Newport.—Hematite pig is firm, and sales have been made at higher prices. Iron ore is in demand, notwithstanding the large quantities which arrive daily. The total foreign shipments of coal at Newport in August were 41,705 tons and 71,862 tons were despatched coastwise; the shipments of coke were 405 tons and 43 tons respectively. The quantity of pig bar and railway iron exported from Newport in August was 26,294 tons, of which 2074 tons went to Buenos Ayres, 1200 tons to Galveston, 1845 tons to Montreal, 1534 tons to Mollendo, 8468 tons to New York, 1092 tons to New Orleans, 1300 tons to Quebec, 1450 tons to Rio de Janeiro, and 1392 tons to San Francisco.

The Forest of Dean.—Trade continues good in the Forest of Dean, except that there are some labour difficulties on hand in the coal interest. Some samples of Forest iron ore were recently forwarded to Staffordshire iron masters, subject on approval to purchases of several thousand tons. Contracts for Bream iron ore have been made at 11s. per ton delivered at Sydney.

Trade of the Port of Bristol.—The amount of customs duties collected at Bristol in August was 72,729*l.* The aggregate amount of customs collected at Bristol during the whole of 1870 was 999,568*l.*

The London and North-Western at Cardiff.—The opening of the new junction line between the Rhymney Railway and the London and North-Western system at Nantybwch promises to do great things for Cardiff. Twenty years since the London and North-Western cast its eyes rather longingly upon Cardiff; now its trains have got there in earnest. Mr. Moon (chairman) and several other directors of the London and North-Western were in Cardiff last week and proceeded to the extreme end of the Bute Low Water Pier, where an opportunity of witnessing the operations at the extensive new dock works was taken advantage of.

The Steam Coal Colliers.—The steam coal colliers in the Rhondda Valley have been threatening another strike during the last few days. The men insist that the masters are not sincere in their desire to submit the recent dispute to arbitration. It is to be hoped that another great industrial conflict will be averted.

The E. S. Judkins (S.).—The E. S. Judkins, a steamer built for the Mediterranean coal trade, made a trial trip on Friday. The E. S. Judkins is a schooner-rigged steamer of 1200 tons burthen. Her length is 218 ft. over all with a breadth of beam of 28 ft. 6 in., and a depth of hole of 18 ft. She is fitted with engines of 99 horse power nominal, capable of working up to four times that power. Mr. Tomlinson, C.E., had the general charge of her construction. The steamer is the property of Messrs. Marychurch and Co.

Welsh Shipping Movements.—The Maggie has cleared from Cardiff for Montreal with 480 tons of railway iron supplied by Mr. R. Crawshay. The Esperanza has cleared from Cardiff for Montreal with 705 tons of railway iron supplied by Mr. R. Crawshay. The Himalaya has cleared from Newport for Stettin with 928 tons of iron supplied by the Tredegar Iron Company. The Valero has cleared from Newport for New York with 547 tons of iron supplied by the Blaenavon Iron Company. The Nunquam Dormio has cleared from Newport for New Orleans with 100 tons of iron supplied by the Blaenavon Iron Company. The Eros has cleared from Cardiff for New York with 1500 tons of railway iron supplied by the Dowlais Iron Company. The Tramet has cleared from Cardiff for New York with 470 tons of railway iron supplied by Messrs. S. Nash and Co. The Wanderer has cleared from Cardiff for St. John, New Brunswick, with 500 tons of railway iron supplied by the Aberdare Iron Company. The Eliza has cleared from Newport for Cape de Verde with 1050 tons of iron supplied by the Risca Iron Company.

Swansea Harbour Trust.—At an adjourned annual meeting of this Trust on Monday, the executive committee reported that under the powers granted to them they had reduced the rate on steel rails to 3d. per ton, and that an Act of Parliament had been passed last session nominating certain ports as places where apparatus for testing chain cables might be erected, Swansea being one of those ports. The report was adopted, Mr. Budd remarking that the reduction of the shipment rates on steel was an equitable alteration.

Boiler Explosion.—An inquest was held on Thursday evening on the body of George Bellamy, the captain of the John steamer, who was killed by the bursting of the boiler at Penarth. Mr. Hannah, surveyor to the Board of Trade, stated that the cause of the explosion was the wearing off the heads of the rivets on the furnace plates. The jury, in returning a verdict of "accidental death," exonerated the owner, Mr. Brain, from all blame, but stated that they considered that the explosion had been really caused by extra pressure of steam by the engineer, who was one of the victims.

Monmouthshire Railway.—The dividend of the Monmouthshire Railway Company for the half year ending June 30, 1871, is to be at the rate of 5½ per cent. per annum. This is the same rate as the dividend paid for the first six months of 1870.

Somerset and Dorset Railway.—It is stated that the works in connexion with the extension of the Somerset and Dorset Railway from Evercreech to the Midland Railway at Bath, will be commenced in March, 1872.

New Industries at Cardiff.—The trustees of the Marquis of Bute have agreed to lease 15 acres of land on the East Moors to the Thames Copper Ore Smelting Company. The probable introduction of other new industries at Cardiff is hinted at.

Trade at Swansea.—A fair average business has been done at the iron works in the Swansea district. The Landore (Siemens) Steel Works are fully employed. The tin-plate works can also barely meet the requirements of consumption. The imports of iron ore continue considerable.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—The speculative element continues to influence the warrant market, and, although the prices of all sorts of iron for manufacturing purposes remain very firm, still, as long as the shipments from Scotch ports continue at the moderate figure they have been at for the last two or three weeks, the price of warrants (taking into consideration the very sensitive state of the market) will "hang" a little. The return of shipments for this week is very fair as compared with those for the similar period last year. As long as the shipments of Scotch pig iron were kept up to 18,000 to 20,000 tons a week, 62s. 6d. for warrants was a fair figure; but even with the present falling off in exports, always looked for at this time of the year, it is not expected that prices, considering the prosperity of all branches of the iron trade, will droop much. Makers are still very firm in their quotations. The shipments for last week were: Foreign, 9109 tons; coastwise, 5576 tons—total, 14,685 tons; same week last year, 10,077 tons; increase for week, 4608 tons; total shipments for 1871, 566,120 tons; for the similar period last year, 433,190 tons—total increase this year, 132,930 tons. The imports of Middlesbrough pig iron into Grangemouth for week ending 9th of September, 1871, were 2015 tons; same week last year, 1050; increase, 965 tons; total imports for 1871, 56,849 tons; 1870, 45,594 tons; increase, 11,255 tons. The prices of warrants are still showing a depressed and fluctuating tendency. Last Wednesday prices were down at 60s. 10d. one month, and 60s. 5d. cash; on the following day there was but little alteration, but on Friday the market was strong, and prices advanced to 61s. 2d. one month, and 61s. 3d. cash. Prices were again down on Monday and yesterday. To-day's market opened steady, 60s. 5½d. cash paid; afterwards the tone became easier, and down to 60s. 4d. cash, and 60s. 7½d. one month was taken.

The Finished Iron Trade.—It is very questionable if there ever was a greater state of briskness in the malleable iron districts of Scotland; certainly there never was such a great production as at present. All the rolling mills are in full operation, yet still, though they are working double shifts, they cannot keep the supply equal to the demand. There is some dissatisfaction being manifested among those workers who have not received the second sixpence of advance in the rate of wages, and this dissatisfaction may unfortunately result in a strike. The iron-founding, boiler making, and allied trades continue to be extremely busy.

Glasgow Street Tramways Contract.—The contract for the formation of the Glasgow street tramways system, the operations connected with which are expected to be begun next week, has been secured at the sum of 88,709*l.* 6s. 8d. by Messrs. Charles Brand and Son, Cumnock, with the condition that Messrs. Faill supply and execute the whole paving work. The specifications to be observed in the construction of the tramways give the assurance that the work will be of the most substantial character, while the standing of Messrs. Brand (who, by the way, have nearly completed the Cumnock and Coylton sections of the Ayr and Douglas Railway) is such as to furnish a guarantee that the undertaking will be carried out in a manner thoroughly satisfactory. The tramways are to be laid on bituminous concrete, the rails are to weigh 60 lb. per lineal yard, and to be attached to longitudinal beams of American white oak resting upon transverse sleepers of the best Baltic timber. All the timber is to be thoroughly creosoted, the nuts are to be galvanised, and the surfaces of the oak and all bolts, spikes, and oak pin-holes are to be thoroughly saturated with Archangel tar at the boiling point. The first section, that which has just been contracted for, will have an extent of about 9¼ miles; and it is expected to be completed within a year from the 1st of the ensuing month of October. Powers have been obtained by the Tramways Committee of the Town Council for the completion of the tramways system by the construction of eleven miles additional. It is expected that when the Glasgow tramways are finished they will be the most substantial in the whole kingdom.

Workmen's Meeting in Support of the Newcastle Engineers.—A crowded meeting of working men was held in the Trades Hall, Glasgow, last week, under the auspices of the Glasgow Trades Council, for the purpose of hearing a deputation from the Nine Hours' League, Newcastle, and to resolve on the measures to be adopted for giving pecuniary support in aid of their fellow workmen who are on strike for the nine hours' system in Newcastle and Gateshead. A large committee was appointed to organise arrangements for collecting funds to send to the Nine Hours' League. With the exception of one clergyman all the speakers were artizans.

Proposed Tramway System for Aberdeen.—A preliminary prospectus has been issued by a tramways company at Aberdeen, with a capital of 50,000*l.*, to be made up of 5000 shares of 10*l.* each. Four branches are contemplated, making in all about 10 miles. One route proposed is from Castle-street, along Union-street and Albyn-place, to Rubislaw quarries. Another, from Union-place, along Hollburn-street and the Deeside-road, to Cults; a third, from the top of Market-street, along George-street, past Woodside, to Buxburn; and a fourth, from the Castle Gate, *viâ* King-street, to Bridge of Don.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday the attendance on 'Change at Middlesbrough was unusually large, and a fair amount of business was done. All kinds of pig iron were in request, but there was the heaviest demand for No. 1 and No. 3. The market closed firm at last week's rates, viz., No. 3, 50s., and the other qualities in proportion. Deliveries are going on very rapidly, but still steamers loading in the Tees are detained longer than they should be. The total make of pig iron last month was 187,053 tons—an increase of 11,788 tons compared with August, 1870.

The Finished Iron Trade.—Throughout the north the condition of the finished iron trade is satisfactory. Rail making is very brisk, but the inquiries are not so numerous. All classes of merchant iron are in good demand. Bar iron makers are well supplied with contracts, and plate and angle iron makers have more orders than they can execute. The nut and bolt works and the wire mills are fully occupied. Founders are busy on pipes and general castings of various descriptions.

The Nine Hours' Movement.—The nine hours' movement at Newcastle has been the cause of a strike in the engineering trade, which has extended over sixteen weeks, and the question has now become a national one. We have frequently referred to the great loss sustained by the masters, and the misery inflicted on the men through the strike. The masters are as determined as ever to win if they can. Week after week they are importing more foreigners. A few days ago another batch arrived from the Continent. Unfortunately for the employers the Nine Hours' League soon find out the workmen who are worth employing, and they induce them to return to their own country. The number of strike hands in Newcastle now is 2074, and this week the League is able to pay them 8s. each, and 1s. per child in addition. This is 1s. per man more than they were able to pay last week, and so rapidly is the subscription lists increasing that they believe that next week the allowance will be still further augmented. All over the country—London, Liverpool, Manchester, Leeds, Birmingham, Sheffield, Glasgow—meetings are being held in aid of the Newcastle men, and the press generally is advocating the nine hours' movement. The men are resolved to remain on strike until the nine hours' system is adopted. At Stockton-on-Tees during the past week a man employed in one of the engineering shops was discharged because he had collected subscriptions in support of his suffering fellow-workmen in Newcastle. This action of the employers caused such an amount of indignation amongst the men that it was feared there would be a general strike in the town. The matter has blown over, but the men have declared that as soon as the battle at Newcastle is ended they will begin at Stockton, and that in the mean time should any man be interfered with for subscribing to the nine hours' movement or for collecting subscriptions they will all turn out.

Engineering.—Great activity prevails in the engineering trade on the Tyne, and at Sunderland, Hartlepool, Stockton, and Middlesbrough. Many of the men who turned out on strike for the nine hours' movement at Newcastle have got work at the shops in the towns named.

Shipbuilding.—Shipbuilders have more work on hand than they can get through. At the beginning of the year it will be remembered that the builders on the northern rivers had as many orders in hand as would occupy them until Christmas. They have built a large number of steamers, and now they have as many orders as will keep them going for several months.

The Mines.—At Guisbro', Brotton, and Skinningrove iron-stone mining operations are being extended on a gigantic scale, and in a short time the output of Cleveland will be very considerably increased. These extensions are absolutely necessary to meet the growing requirements of the blast furnaces on Tees-side, where the make of pig iron far exceeds that of any other district in the world.

The Coal and Coke Trades.—The coal and coke trades in Northumberland, Durham, and Yorkshire are in a satisfactory state. The home demand is large and the shipments are very brisk. On Tees-side, on account of the great number of iron works of various kinds, the consumption of coal and coke is enormous. The collieries in South Durham are kept fully at work.

OPENING OF THE MONT CENIS TUNNEL.—The first train passed through the Mont Cenis Tunnel on the 13th, accompanied by Signor Grattoni, the engineer, the director-general of the Upper Italian Railway, and several officials. The train arrived at the northern outlet in 40 minutes. The maximum temperature inside the carriages was 77° Fahr. Two hours later the train returned to the Italian side, the journey occupying 55 minutes. The tunnel was then found entirely clear of the steam discharged during the previous journey. The trial was a perfect success.

LONDON TRAMWAYS.—The South London system of the London Tramways Company was on Monday further developed by the opening of the new line from Clapham and Brixton to Blackfriars Bridge, *viâ* Kennington-road, Lambeth-road, St. George's-circus, and Blackfriars-road. The cars run every ten minutes. In the early part of the day the cars met with some delays, owing to the difficulties of working the sharp curves on the line at the junction of the Kennington and Lambeth roads, and also at St. George's-circus. A large body of workmen were at once employed in rectifying the evil, and in the latter part of the day the whole of the line, including the curves, worked smoothly. The fares are 3d. between Blackfriars and Brixton or Clapham, 2d. between Blackfriars and the Horns at Kennington.

AIR-TIGHT STOPPERS.

As a general rule the successful results of inventive skill, applied to the production of small novelties destined to find a place in every household, escape notice till they become so common that they are accepted naturally, without awakening any question as to their first origin.

Nevertheless there is much that is instructive in many of these apparently simple inventions, much in the history of their first conception, and their early growth that is well worth knowing. All of our readers are familiar with the peculiar substitutes for corks which have lately come into general use for closing wide-necked bottles, and which bear the stamp of "Thompson's patent air-tight stopper;" but few, if any, would suppose that to perfect this inglorious little contrivance had cost a moderate fortune in the numerous experiments needed to complete its details, that its manufacture calls into requisition the most complete machinery for its successful production, and that it bids fair to become an important branch of manufacture.

In 1864 Messrs. Thompson first commenced their experiments in this branch of mechanical art, with a view to supply a simple and efficient means of stoppering bottles such as are used for pickles and preserves.

The problem to be solved, though at first sight simple and easy enough, turned out to be one of unusual practical difficulty; and upwards of three years' work accompanied by heavy outlay, besides scores of ingenious, though ultimately unsuccessful, designs of stoppers attest at once the obstacles overcome, and the perseverance required. It must not be supposed that these various unsuccessful designs were but so many blind efforts to stumble upon the right thing by a series of exhaustive trials. On the contrary, every one was a carefully considered improvement over its immediate predecessor, and each failure arose from some cause only possible of detection by actual and extensive application of the stoppers in closing bottles filled with the most dissimilar compounds. In many cases a final verdict could not be pronounced on a particular form of stopper until it had been in use for some months, or even tried abroad under various conditions of climate to ascertain whether it would stick or become otherwise unsuitable. While these experiments were proceeding trouble was taken in alterations of tools and machines to correspond with the alterations made in the stoppers themselves.

At length about three years since Messrs. Thompson succeeded in the production of a stopper which has answered every expectation, and which is now manufactured in enormous quantities. Before describing the stopper in question, and its process of manufacture, it may be well to mention one of the greatest difficulties encountered in developing this trade, namely, the difficulty, amounting to a practical impossibility, of getting bottles made to suit some of the designs of stoppers tried. The obstacle lay in the annealing of the glass, as the necks "threw" out of shape; and this was the more annoying inasmuch as this "throwing" of the bottles caused the failure of several stoppers otherwise satisfactory. At first the stoppers were made to fit like capsules over the necks of the bottles—but it was found that, as the necks were more distorted in the exterior than the interior, internal stoppers alone afforded a reasonable chance of success, and these are now exclusively made. When it is considered how many millions of corks are annually used for stopping bottles of various condiments, and that the trouble and expense involved in the various processes of covering these corks with leather, wax, cement, bladder, or metallic capsules—a serious item in a large business—some conception will be formed of the extensive field such a trade offers. Beyond the mere labour of first securing the corks in the bottles, which is sixfold of that required in using Thompson's stopper, there is also the inconvenience to the consumer in removing the wax, &c., and the impossibility of reclosing the bottle properly and quickly. The principle of the air-tight stopper is such that no matter how often it may be withdrawn it makes a perfect joint when reinserted. Doubtless, ere long, the ordinary method of securing jars will be superseded, since these stoppers are in every way superior in efficiency, economy, and convenience for after use; and of course one set of stoppers would last for many seasons.

Fig. 1 shows a section of one of these stoppers, suited to a bottle having a 2 in. neck, while *a*, *b*, *c*, *d*, *e*, *f*, *g*, and *h*, show the details separately. The cap, *h*, has a recess, h^1, struck in it to receive the lever, *f*, when the stopper is expanded by pressing the same down in the arc, f^1. The part *g* is a cylinder of metal varying in diameter, as shown, open at the top and bottom, and having the flange shown at the top, over which the cap, *h*, is closed. Inside the cylinder, *g*, the second cylinder, *b*, works freely up and down, *b* is open and flanged at the bottom, while at the top it is corrugated on the circle as shown. The small corrugated pan, *a*, fits the under side of the cover of *b*. Through the flat part of each is a narrow slit, and through this slit the hook, *i*, passes; this hook is made of iron about $\frac{1}{16}$ in. thick. When the two parts, *a* and *b*, are put together, and the hook, *i*, inserted, a cover of pure tin is put on at the bottom, and closed over the flange of *b* as at *k*. The object of using pure tin is that tin-plate would not suit for many compounds, and it is necessary to avoid all corrosion. The cylinder, *g*, is then placed over *b*, and the bridge, *c*, of iron, is placed in position. It will be seen that its ends rest upon the ledge formed by the difference of diameter in *g*. The side and end views of this bridge, at *c* and *d*, show that it is of considerable strength; and, in fact, such strength is necessary to withstand the comparatively great strain it has to bear when the lever, *f*, is shut down. At the centre of the bridge a narrow slit admits of the passage of the hook, *i*. The lever, *f*, has also a slit which engages with the hook; its under side, f^2, forming a cam which acts upon the bridge, *c*, on each side of the slit through which the hook passes.

FIG. 1.

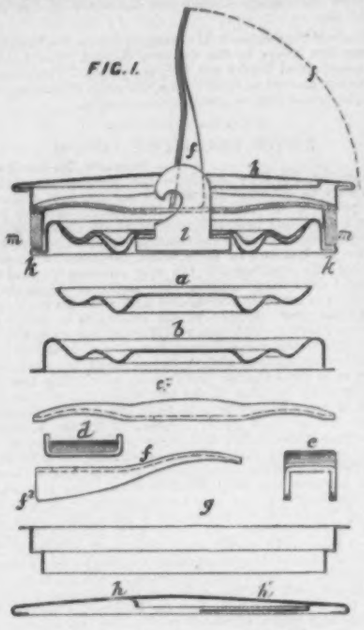


FIG. 2.

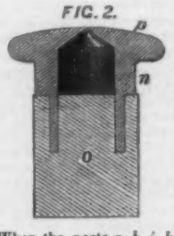


FIG. 3.

When the parts *a*, *b*, *i*, *k*, *g*, and *c* are put together, in the order named, the lever, *f*, is placed upon the bridge, *c*, engaging with the hook, *i*, in a vertical direction, as shown. The cap, *h*, is then put on, and closed over the flange of *g*. When this is done, the metallic part of the stopper is in every respect complete.

The next and final operation is putting on the rubber packing ring, *m*. This was at first an operation of considerable difficulty, as these rings are normally much smaller in diameter than the stopper. Now, however, they are put on by a most simple and ingenious little tool, which is self-acting, and which enables one girl to put on sixty gross of rings in a day. This tool has, so to speak, a system of mechanical fingers which are kept shut by a spring action. As each ring and stopper are presented to them, they open by the forward movement of a cone, the ring is stretched, placed round the stoppers, the tool is drawn back, closing as it recedes, and the ring is in position; all this being done with such quickness, that only an eye accustomed to analyse mechanical movements could by any possibility tell how the thing is done. The action of the stopper will easily be understood. It is placed in the neck of the bottle in the position shown in Fig. 1, with the lever, *f*, vertical. In this position it fits the neck quite loosely, so that it may almost be dropped in, at least easily withdrawn. The lever is now pressed down till it lies flat with the cap. The action which takes place makes the joint perfectly tight by the expansion of the rubber, *m*. This expansion is caused by the lever, *f*, drawing up the hook, *i*, and with it the cylinder, *b*. Thus the flanges, between which the rubber ring lies, are brought nearer together, and a very forcible expansion is the result. When so shut down, one of these stoppers will keep hold in a bottle with the most extraordinary tenacity; but as soon as the lever is raised it can easily be taken out. As the caps can be impressed with any device they answer for trade-marked capsules as well as stoppers.

Figs. 2 and 3 show an elevation and section of stopper for small-necked bottles. Of these immense quantities are made; and the wonderfully low price at which they are produced shows what may be done with effective appliances. The part, *n*, is of wood, and it is cemented into the cork, *o*. The wooden part, *n*, has a hole nearly through its centre, so that a corkscrew may be used to extract the cork when necessary. The top of the wooden part, *n*, is covered by a metallic capsule, *p*, upon which any trade mark required is impressed.

The speciality about these stoppers is the extraordinary rapidity with which the very beautiful machines used in making them turn out the different parts. One girl can make upwards of 100 gross of the wooden plugs in a day, her duties being confined to feeding the machine with wood as fast as it will take it in. The production of the corks is equally rapid.

RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 2608, 1s. 6d.) William Richard Middlemore Thomson, of Glasgow, patents, as the agent of Treat Timothy Prosser, of Chicago, a wonderful apparatus for enabling the latent heat given off during the condensation of exhaust steam to be returned to the boiler from which the steam is supplied. This apparatus depends for its action upon the notion that if two tubes are arranged concentrically one within the other, and if the outer tube radiates and the inner tube receives heat, that then the intensity of the heat at the surface of the inner tube will be as much greater than that which exists at the inner surface of the outer tube, as the diameter of the former is less than that of the latter! In other words, Mr. Prosser apparently believes that the surface temperature under the above circumstances would be inversely as the diameter of the tubes. If this supposition was correct, a fine wire passed through the axis of a large tube surrounded by boiling water would be raised to a white heat at least!

(No. 2609, 4d.) John Carrington Sellars, of Birkenhead, patents making metal founder's blacking by mixing sea weed, sea grass, or sea plants with coke, charcoal, or other carbonaceous matter, or lime, chalk, or clay. The particulars of various mixtures are given in the patent.

(No. 2615, 8d.) George Haseltine, of Southampton-buildings, patents, as the agent of Peter Fitz Randolph, Augustus Knapp Van Horne, and Henry Vroom Vorhees, of Illinois, U.S., the use, for polishing irregular surfaces such as ploughshares, &c., of an endless belt covered with emery and passed over suitably arranged pulleys. Such belts covered with ground glass have long been in use for polishing or "sand papering" wood.

(No. 2616, 10d.) Edward Dumaresq Thomas, of Abergavenny, patents—under the idea apparently that it is new—the use for hoisting purposes of a windlass having two barrels of different diameter on the same axis, the smaller barrel receiving the hoisting rope, while around the larger is placed the hand rope through which the actuating power is exerted. Our opinion respecting the novelty of this contrivance does not agree with the patentees.

(No. 2619, 1s. 4d.) John Yule, of Glasgow, patents methods of arranging auxiliary engines for assisting existing pumping engines at mines. The details of these plans could not be explained clearly without the aid of drawings which we have not room to introduce here. We may mention that Mr. Yule has in his specification presented the English language with a new verb, namely, to "auxiliate." This is stealing a march upon our United States friends.

(No. 2620, 8d.) Louis Sterne, of Great Queen-street, Westminster, patents the method of securing elastic tyres on wheels, illustrated by us on page 415 of our tenth volume.

(No. 2624, 10d.) Leonard Cooper, of Manchester, patents, as a communication from Myles Cooper, of Buenos Ayres, arrangements of wire rope tramways in which two parallel endless ropes are employed, these ropes passing at each end of their course over vertical pulleys. Two parallel lines of rope are thus obtained on which the wagons, or other receptacles for the materials to be conveyed, are carried. The arrangements for placing the wagons on and removing them from the ropes are simple and effective, and altogether the plans are well worthy of notice. We shall very probably have something more to say about them.

(No. 2630, 10d.) Robert William Thomson, of Edinburgh, patents various methods of applying metal shoes for the purpose of protecting his india-rubber tyres. Considering how much has been said concerning the everlasting properties of india-rubber tyres, it is curious that so much ingenuity should be expended in affording them protection.

(No. 2643, 8d.) Willian Rudd Oswald, of Sunderland, and George Ough, of 57, St. Mary Axe, patent the use of fans for improving the ventilation of the stoke-holes and engine rooms of steamships, it being proposed to drive the fans by an endless cord or band from the main shaft of the engine, and to arrange it so that a constant current of air is drawn in through the engine room and delivered into the lower part of the stoke-hole. The employment of fans for improving the ventilation of stoke-holes has been often proposed, and it has in a few instances been carried out. There may, however, be some novelty in the general arrangement claimed by Messrs. Oswald and Ough. We should ourselves prefer to drive the fan direct by a small independent engine.

(No. 2657, 6d.) Herbert Vesper, of Southsea, patents employing, as a substitute for an eccentric, an arrangement of tappet gear for moving the slide valve of an ordinary direct-acting engine, stops on the piston rod being made to strike—near each end of the stroke—against levers by which the slide valve is shifted. This is an old idea.

EXPLOSIVE COMPOUNDS.

DYNAMITE AND ITS MANUFACTURE.

HAVING in previous articles considered the progress made during the past five years in gunpowder and gun-cotton, we have in the next place to notice dynamite, one of the most formidable, and at one time one of the most promising, rivals of gunpowder for special purposes. The base of dynamite is nitro-glycerine, which ranks amongst the remarkable materials employed to replace gunpowder as destructive agents. It was discovered by Sobrero in 1847, and is produced by adding glycerine in successive small quantities to a mixture of one volume of nitric acid of sp. gr. 1.43, and two volumes of sulphuric acid of sp. gr. 1.83. The acid is cooled artificially during the addition of the glycerine and the mixture is afterwards poured into water, when an amber coloured fluid separates from it. This fluid is insoluble in water, possesses no odour, but has a sweet pungent flavour and is very poisonous, a minute portion placed on the tongue producing a violent headache. The liquid has a specific gravity of 1.6, and soldifies at about 5° C. or 40° Fahr. The properties of nitro-glycerine are tolerably well known; it simply burns when flame is applied; if paper be saturated with it and struck sharply a somewhat violent detonation is produced. In 1864 Mr. Alfred Nobel, a Swedish engineer, applied nitro-glycerine to the purposes of blasting. He first used gunpowder saturated with nitro-glycerine, which burned more brightly in the open air than unsaturated gunpowder, but its destructive effect under confinement was from four to six times that of pure powder. The oil itself cannot be exploded by an ordinary fuze, so Mr. Nobel attached a small charge of gunpowder to the end of the fuze and by this means the explosion of nitro-glycerine was effected.

But although a very useful agent, nitro-glycerine often proved itself to be a highly dangerous one. The frequent and fatal accidents which occurred with it between the date of its practical application, and the year 1868 will doubtless be fresh in the memory of our readers. On the 3rd of April, 1866, the West India Company's steamer, European, whilst unloading at Aspinwall, had her decks ripped up and her sides blown out, whilst a wharf 400 ft. long was literally torn to pieces, about fifty persons being killed and a number wounded by an explosion of nitro-glycerine on board the vessel. On the 16th of the same month, two cases of the oil arrived at San Francisco by the Pacific mail steamer and were taken into that city, where they were no sooner deposited than they exploded, the results proving terribly fatal to human life. In Sydney, New South Wales, too, about the same time, two packages of the oil exploded in a store in Bridge-street, with disastrous results, whilst at home later still we have had two fatal explosions, one at Cwm-y-glo, near Carnarvon, and the other in the suburbs of Newcastle. Two other cases of explosion occur to us; one in which a carman greased the wheels of his cart with nitro-glycerine, and the other where the nitro-glycerine was frozen, and the workmen placed lumps of it on a stove to thaw. The cause of the explosions was here very apparent, as it also was in the case of the Cwm-y-glo accident, where the packages of nitro-glycerine were being carted to the slate quarries, a package having been placed loosely on the front-board of one of the carts. This package doubtless fell off the cart, and, exploding, caused the explosion of the remainder of the packages. Although there is no proof of the manner in which the other accidents were actually caused, it is tolerably certain that a blow must have been in some way or other administered to the cases containing the oil. Therefore, since nitro-glycerine has been largely used in the past with a comparatively small number of accidents, and since its manufacture is still carried on upon a large scale for conversion into dynamite, it is only fair to assume that with reasonable care in manipulation, accidents with nitro-glycerine would not occur.

The accidents, however, which resulted from the use of nitro-glycerine, led Mr. Nobel to experiment with the material in various ways with the view of rendering it less dangerous. The first result was the discovery that it could be rendered non-explosive, either from percussion or heat, by mixing with it methylic alcohol. When required for use, water was added which absorbed the spirit and allowed the oil to sink to the bottom of the vessel whence it was drawn off for use, its explosive nature being restored. This method of protecting the treacherous oil was adopted to some extent; it answered the purpose during storage or transit, but, at the time of use, all the dangerous properties of the oil were present, and accidents arising from carelessness continued to occur. Mr. Nobel, satisfied that the protective arrangement was only half a solution of the difficulty, continued his researches, and early in 1868, he succeeded in effecting a new combination in which nitro-glycerine was rendered perfectly innocuous except under the actual conditions of work. This desirable end was attained by mixing the oil with silica—fine gravel for instance—the compound resembling in appearance coarse brown sugar, a little damp. To this substance Mr. Nobel gave the expressive name of "dynamite," and with it he made a series of experiments at the Merstham Greystone Lime Works, in July, 1868, the particulars of which will be found at page 52 of our sixth volume. The object of those experiments was to illustrate the safe and harmless character of dynamite under any other conditions save those of actual work, and to demonstrate its resistless energy when fired by a percussion fuze. The experiments were thoroughly successful, and proved beyond a doubt that dynamite could not be exploded by concussion, and that if placed on a fire or ignited in the ordinary way it only burned slowly out. When, however, it was fired by a percussion fuse, even in the open air, all its intensity of power was fully developed, and was increased by exploding it in water or under conditions of confinement.

The most severe tests for safety failed to show that any danger was present in this material, whilst, on the other hand, there was no condition under which its violence was not fully developed when fired with a detonating fuze. One out of many illustrations of its power is worthy of notice here. A cylindrical block of wrought iron, 12½ in. high and 10½ in. in diameter, and having a 1 in. hole bored through its centre, was used. The bore-hole was lightly filled with dynamite and fired by a time fuse, the charged not being plugged. The explosion split the cylinder in two equal halves longitudinally to the axis of the bore, one-half being bedded in a grass bank 80 ft. away from the place where the charge was fired, and the other half being found about 50 ft. in an opposite direction, having been stopped by a mass of limestone rock. The iron showed a clean split, the bore-hole being enlarged to 1¼ in. at the centre, showing the enormous compression the metal had undergone at that point. A charge wrapped in thin paper and fired under water exhibited the same resistless power, and demonstrated the fact that dynamite is unaffected by moisture. The only point of doubt that arose in our mind at the time of witnessing the experiments, was as to whether any mechanical separation of the silica from the oil or chemical change in the compound could occur in the course of time which would render dynamite as dangerous as nitro-glycerine. Mr. Nobel, however, stated that there was no fear of such an occurrence, inasmuch as he had had dynamite in store for very lengthened periods subject to extremes of temperatures—some very high—and that it retained its original condition under some very trying tests.

The stability of dynamite has been practically confirmed by extensive and daily use in mines on the Continent, and by a limited use in England, as well as by the large quantities which are stored at the factories. Beyond this, the most careful investigation has shown that there is not the slightest ground for apprehension on that score. Under continued exposure to the direct rays of the sun during the whole of the summer of 1865—an exceptionally hot one—not the slightest chemical change could be detected. The same results were obtained with a parcel of dynamite exposed for forty days to a temperature varying between 150° and 200° Fahr. All nitrated, or rather hypo-nitrated organic compounds are liable to spontaneous decomposition—or what is understood by this hackneyed and ridiculous term—unless they are completely rid of free adhering nitric acid. The reason is that the free acid produces a local decomposition which sets hypo-nitric acid free, the latter producing a new local decomposition, and so on until sufficient heat is evolved to set fire to the compound. There is no difficulty in ridding dynamite of free acid; but in the case of cotton, or any other fibrous substance, the utmost care is required, as free acid will adhere in spite of repeated washing. It will be seen that the method of percussively exploding the charges of dynamite adopted by Mr. Nobel is precisely similar to that devised by Mr. Brown for exploding gun-cotton, as described in a previous article upon the latter material. It is, however, but fair to state that Mr. Nobel used his percussion fuzes at the Merstham experiments, to which reference has been made, in July, 1868, whilst the experiments with gun-cotton exploded in the same way, were not carried out until the 22nd of January, 1869.

It is generally conceived that nitro-glycerine, and consequently dynamite, is more dangerous, and more easily exploded when in a frozen state than when liquid. But this conception is erroneous, inasmuch as it is really difficult to explode it when frozen, and we have a case in point to prove this. A charge of nitro-glycerine had become frozen in a hole at a quarry near Bangor, and was fired three times with gunpowder without being exploded. A small cartridge containing about half an ounce of the liquid oil was then inserted in the blast hole on the top of the frozen charge, and on being fired, exploded the whole charge, which did its work most effectually. Some experiments made with frozen dynamite tend to prove that it cannot be made to explode even by percussive fire. Percussion fuzes have been exploded in it, but they have only either blown it away in fragments, or have set it on fire, so that it burned quietly away. These facts at once silence any theoretical objections which may be raised to this compound on the score of its explosiveness whilst in a frozen condition.

There can be no question as to the real value of dynamite as an explosive for mining purposes. This value is fully recognised in Germany, where depôts have been established in every mining district throughout the country. A firm at Cologne, who are the largest manufacturers of blasting powder in Western Prussia, have long been converts to dynamite, and have taken up its agency. In Sweden and Norway the consumption is very large, as it is also in the United States and California. It would doubtless appear strange that dynamite—possessing as it does so many and great advantages—should be so little known and so very much less used in England. The truth is that dynamite would undoubtedly have had as great a run in England as on the Continent, had it not been that a short Act was quietly smuggled through Parliament during the Session of 1869. It is known as the "Nitro-glycerine Act," and it virtually prohibits the importation, exportation, manufacture, sale, or even possession of "every substance having nitro-glycerine in any form as one of its component parts or ingredients." The Act is a very snug little affair, and if it was not promoted by the gun-cotton party, why it ought to have been; it cannot fail, however, to afford them much satisfaction. It will thus be seen that extraordinary impediments have been thrown in the way of the use of dynamite in this country, and the consequence is that not more than 20 tons have been sold in Great Britain since the Act was passed. Messrs. Webb and Co., of Bangor, are the agents for Mr. Nobel—whose factory is at Lauenberg—but they inform us they are literally doing nothing, although they have constant applications for the material. At several mines where dynamite has been tried the managers are constantly pressing for further supplies, but of course to no purpose.

With regard to the power of dynamite we may observe that its destructive action is estimated to be about ten times that of an equal weight of gunpowder. If, therefore, we take the average work done by 1 lb. of gunpowder at 32,832 lb.—an average obtained from actual practice in six different places, and in various kinds of rock—we get 328,320 lb., or about 146½ tons, as the work done by 1 lb. of dynamite. Hence, although its cost is greater than that of blasting powder, its use is attended with great economy. We have ascertained this economy to be in one mine in Cornwall as much as 50 per cent., whilst it is stated that the St. John del Rey Mining Company doubled their workings at two-thirds the cost of gunpowder. We are also informed that this same company saves 1000*l.* per month by the use of dynamite as against gunpowder. The greatest economy results from its use in hard rock, a considerable saving being effected by its means in the labour of the miners, and in the time occupied in performing a given amount of work, as much fewer and smaller blast-holes are required than when gunpowder is employed. We are not aware that any comparative experiments have been made with dynamite and gun-cotton, and which would afford data as to their relative power. Taking, how-

NUT TAPPING MACHINE.

DESIGNED BY MR. PHILIPPE KOCH, ENGINEER, MANCHESTER.

FIG. 1.

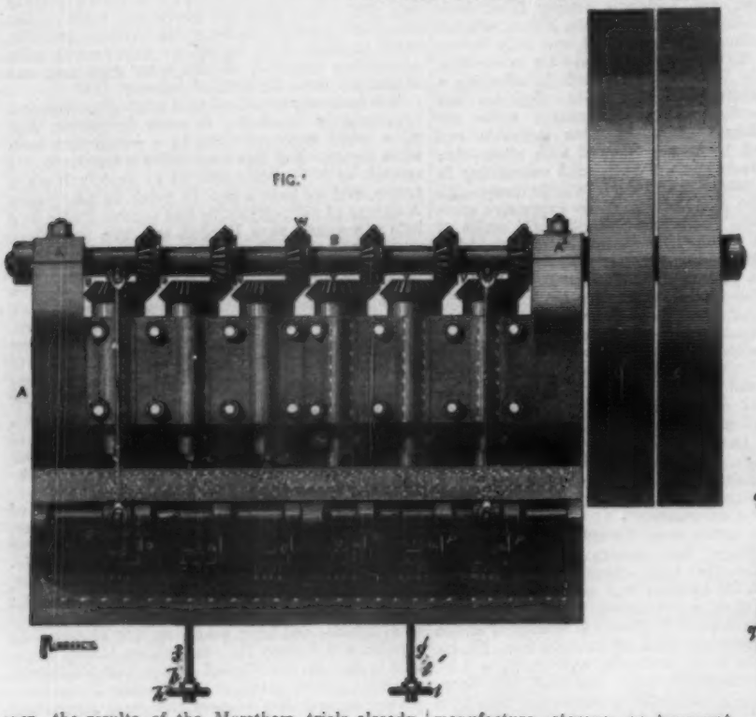


FIG. 2.

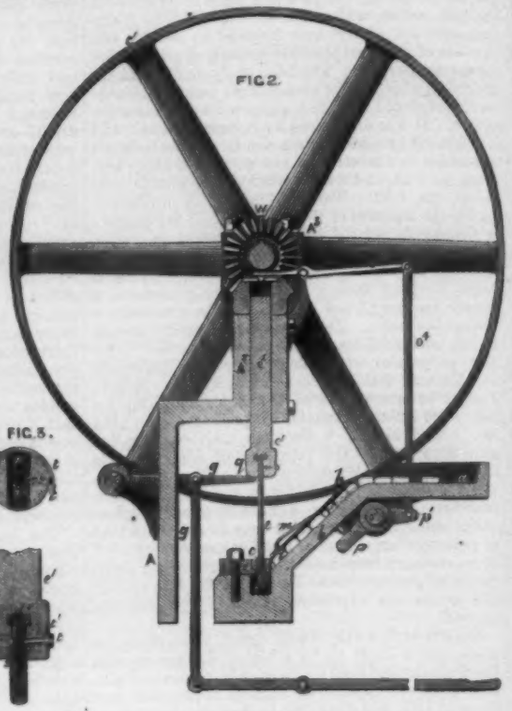


FIG. 3.

ever, the results of the Merstham trials already referred to, and those of the gun-cotton experiments in January, 1869, we should certainly say that dynamite was the stronger of the two. Our reasons for this conclusion are founded upon the circumstances that at the latter experiments 5 lb. of gun-cotton failed to more than shake a palisade, which we think 5 lb. of dynamite would have demolished. This question, however, can only be settled by comparative experiments, which at present there is but little chance of seeing carried out, at any rate in England.

The most recent modifications introduced by Mr. Nobel in the manufacture of explosive compounds, into the composition of which nitro-glycerine enters, are to be found in two kinds of blasting powder, which were introduced by him towards the close of last year. The composition of the two types of this powder is as follow: No. 1. Pulverised nitrate of barytes, 68 parts; charcoal of light texture, 12 parts; nitro-glycerine, 20 parts. No. 2. Pulverised nitrate of barytes, 70 parts; powdered resin, 10 parts; and nitro-glycerine, 20 parts. The charcoal is carbonised at a low temperature, and consequently still contains hydrogen. An addition of from 5 to 8 per cent. of sulphur to either of the above mixtures gives a powder which fires more briskly, but, at the same time, it increases the danger in the manufacture, carriage, and application of the powder. The method of using these powders is to place them in cartridge cases, the powder being covered with a little mercurial or other fulminate before the case is closed and primed. The cartridge is placed in the bore-hole and tamped in the usual way, and is fired either by a fuze or by an electric wire. The fulminate, acting on the nitro-glycerine, ignites the whole charge instantaneously.

In our opening remarks we referred to the dangerous character of nitro-glycerine, as illustrated by several catastrophes. In concluding we would bear testimony to the comparatively harmless nature of dynamite, as evidenced by the Merstham experiments, and further by a circumstance which came to our knowledge in 1868. In that year a tremendous explosion of nitro-glycerine occurred at Mr. Nobel's factory at Stockholm, which destroyed the works. Close by was a store of dynamite, which, after the explosion, was found scattered about in all directions, but none appears to have been exploded. The further evidence of the safety of dynamite is of a negative character, and consists in the absence of any record of accident either in manufacture, storage, or transport. Two accidents have happened with dynamite while in use in mines, but they arose from sheer carelessness. In one instance the tamping was incautiously removed after a misfire, an operation which ought not to be allowed in any case; and in the other a half-witted miner, having heard that dynamite burned harmlessly in the air, lighted the fuze of a charged cartridge, and held it in his hand until it exploded. A third accident of a special character occurred at Wigan, where a workman was blasting a large mass of iron on a very hot day and with loose dynamite, not confined in paper cartridges. He fired the charge, which was not strong enough to break up the iron, and he forthwith commenced to recharge the hole with dynamite. While ramming the powder down with a wooden rammer it exploded, blowing the rammer out of the man's hand, and injuring him. He was by no means seriously injured, and would have recovered but for the circumstance that one or two small splinters from the rammer had entered his arm, and being saturated with nitro-glycerine they poisoned the flesh, and the man died in a fortnight. Three men were standing by at the time of the accident, one of whom had 8 lb. of dynamite in a bag with him. The dynamite took fire and burned slowly away, slightly scorching the man who was holding it, but not hurting the other two men.

There can be no doubt that the explosion arose from the extreme heat of the iron consequent on the explosion of the first charge, the hot sun rendering the dynamite more sensitive, the ramming down of the powder while in this sensitive state causing it to be fired. This, in fact, was subsequently proved to be so by Mr. Webb—to whom we have already alluded—who took a lump of hot coke and placed some loose dynamite on it. The dynamite soon began to smoke, and after it had smoked awhile Mr. Webb touched it with a rod, and it immediately disappeared with a kind of semi-explosion. The experiment was repeated several times with the same results, and the accident would not have occurred if the bore-hole in the iron had been sponged out. These are the only accidents we can discover, and they are such as must and will occur, however safe the explosive may be to handle, where carelessness or thoughtlessness exist.

THE INDIAN SERVICE.—The death is announced of Colonel Boileau, R.E., who died recently at Cuddalore, Madras. The death may be also noted of Captain Basseri, R.E.

NUT-TAPPING MACHINE.

THE engraving published above illustrates a new machine for tapping nuts at a high speed, which has been designed and lately patented by Mr. Philippe Koch, of Manchester. As will be seen from the drawing the machine is constructed with a horizontal table on which the nuts to be tapped are placed; from this table extends downward in an inclined plane a plate, in which are formed grooves or channels through which the nuts are conducted to the taps, formed on the lower end of stems or rods fitted in the sockets of vertical spindles, which rotate in suitable bearings at the top of the machine. The inclined grooves or channels terminate in horizontal recesses which hold the nuts centrally under the rotating taps, the outer end of these recesses having a flange for preventing the passage of the nuts beyond the proper position under the taps. Below the inclined bed of the machine are treadles which are connected by rods to the tap spindles. These treadles are so arranged that by the pressure of the foot they raise the spindles to which they are connected. After each nut has been tapped it is necessary that the tap should be raised to allow the next nut which has been stopped at the bottom of the inclined groove to pass into the proper position, but this passage of the nut cannot take place until the tap has risen. The bottom nut is retained in the groove by a shaft under the inclined bed, provided with springs which extend over the grooves. The free end of each spring is in the proper position to rest on the bottom nut in each groove, and these springs resting on the nuts retain them in the groove until the taps have been raised sufficiently to allow the nuts to pass under them, and at the moment when this occurs the springs are raised and the nuts slide forward under the taps. The raising of these springs is effected by mechanism in connexion with the treadle; for this purpose the shaft of the springs may be connected to a vertical rod, which at the proper moment is operated by one of the spindles, the rod being thereby slightly raised, and raising the springs releases the nuts. When the operator removes his foot from the treadle the spindles and taps descend by their own gravity, the taps enter the nuts which have just passed under them from the inclined grooves; the springs again close upon the next nuts which now lie at the bottom of the inclined grooves, and the operations are repeated as before. The spindles and taps rotate continuously in one direction, and as the taps pass through the nuts the latter are collected upon the stems of the taps above the screwed or cutting portion. When a certain quantity have been thus tapped and collected, the taps are withdrawn from the spindle sockets, and the nuts removed, after which the taps are again inserted in the sockets without stopping the machine. To effect this the sockets and the ends of the taps are constructed as follows: The socket is circular for the greater part of its depth, but the end for about three-eighths of an inch is left square. A similarly small portion of the extremity of the stem of the tap is also made square to fit the square part of the socket. A shallow groove is made around the circular part of the stem within the socket, and a spring pin projects through the socket into the groove, its pressure being just sufficient to prevent the falling of the tap from the socket, but not sufficient to prevent its easy removal and insertion.

In the engravings Fig. 1 is a front view of the machine;

JANICKI'S FLOATING DOCK.

FIG.3

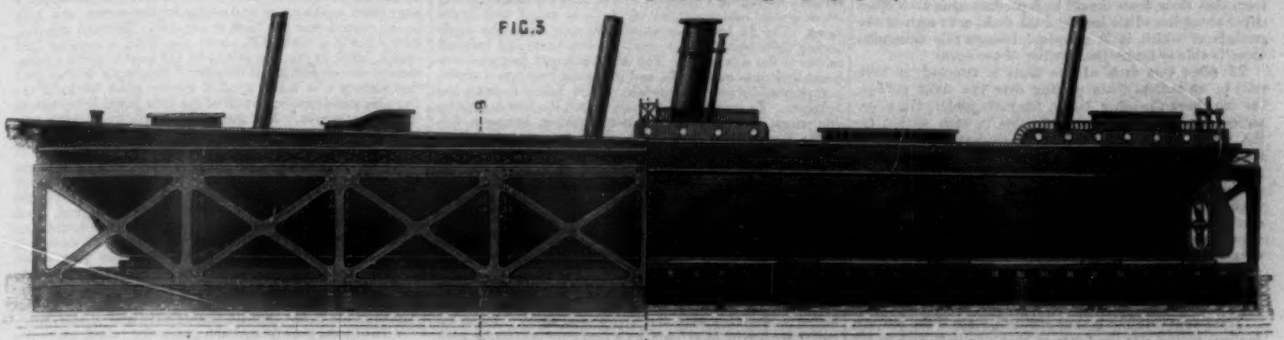


FIG.4.

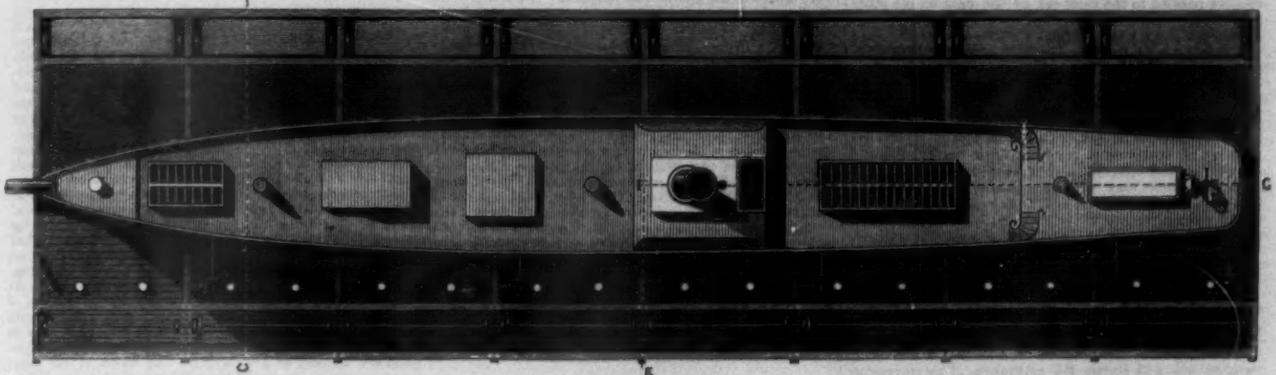


FIG.1

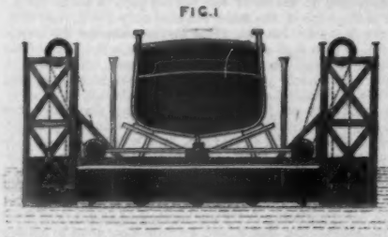


FIG.2

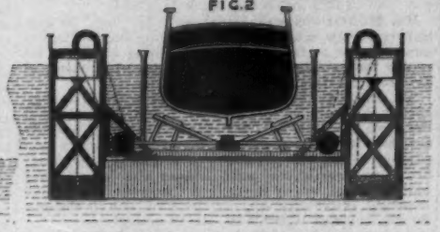


Fig. 2 is a vertical transverse section; and Fig. 3 is a section to an enlarged scale, illustrating the arrangement for holding the taps in the spindles.

The frame of the machine is shown at A; and *a* is the horizontal table on which the nuts are placed, *b* the inclined plate with the grooves or channels, b^1, through which the nuts, *c*, are conducted into the horizontal recesses, *c*, under the taps; c^1 is the flange at the end of each of the recesses for preventing the passage of the nuts beyond the proper position; c^2 is a cavity or space below each of these recesses to allow the tap to descend far enough through the nuts.

The machine shown has two sets of taps, *d* and *e*, each set being operated by a separate treadle for raising them, the levers, *f g*, being operated through the treadles, *h i*. One of the levers, *f*, is arranged below each spindle, d^1, and they are all keyed on the shaft, *j*, while the levers, *g* (one of which is arranged below each tap spindle, e^1), are all fast on the shaft, *k*. The free end of each of the levers, *f g*, projects under the bottom of one of the tap spindles, as shown in Fig. 2, far enough to raise the said spindle without touching the tap. With this arrangement it is obvious that, by depressing either of the said treadles, all the taps of one set will be raised simultaneously, and when the treadle is released they will descend by their own gravity.

The springs for holding the bottom nut in the grooves, b^1, while the taps rise, are also arranged in two sets, *l m*, and they are raised by the levers, *o p*, keyed fast on the shaft, o^1 and o^2. One arm, 1, of each of the levers projects over the outer tap spindle of each set, and when either set of taps is thrown up by the treadle the end of the spindle acts on the arm, 1, of the corresponding lever, and acts on the levers, *o* or *p*. From each of the springs a pin, 2, projects down through a slot in the plate, *b*, and lies in contact with one of the said levers, and by this means the spring is raised and releases the nut just as the tap is raised to its highest position.

RAILWAY KEYS.—A tender of a Melbourne firm has recently been accepted by the Victorian Government for 10,000 railway keys. This decision has been received with much satisfaction in Melbourne.

TECHNICAL EDUCATION.—We notice that the classes of the Birkbeck Institution are announced to commence on October 2nd. The pupils of this institution who have attended the examinations of the science and art department during the present year have been more successful than on any previous occasion, and one member has succeeded in obtaining a scholarship at the Royal College of Science.

JANICKI'S FLOATING DOCK.

M. JANICKI, one of the members of a firm of contractors for public works in Paris, has recently applied to the study of a system of floating docks, the great experience he has gained by a long practice, in the application of compressed air, in sinking the cylinders for bridge foundations. He has patented in this, and several other countries, a pneumatic floating dock, with lateral moving floats. The more easily to understand the distinctive features of this dock, we may consider briefly the arrangements of the Bramwell dock, which it somewhat resembles. In 1867 Mr. Bramwell built for the island of St. Thomas a floating dock 295 ft. long, 98 ft. 6 in. wide over all, 76 ft. wide inside, 41 ft. 6 in. high, able to lift a ship drawing 23 ft. 6 in. of water, and of 4000 tons displacement. The dock is composed of two longitudinal lattice girders, containing between them six water-tight pontoons, forming the lower platform, and which are solidly connected to two frames, but which can be quickly detached. Twelve floating caissons are placed, each between four vertical girders, so that they can be shifted vertically with reference to the pontoons. This movement is regulated for each caisson by three long vertical screws, the heads of which carry mitred pinions gearing into spur wheels on a horizontal shaft. Each of the two main girders carries in the centre an engine house. In each chamber is a tubular boiler supplying two engines, which drive the pumps, and two other engines actuating the vertical screws.

The whole of the dock is thus, so far as its manipulation is concerned, divided into four independant parts, each comprising an engine, three pumps, and nine vertical screws.

The bottom pontoons, strongly secured to the two girders, become dependant on each other in such a way that they follow the distribution of load in the length of the dock when a weight has to be lifted, the pontoons least weighted coming to the aid of those most loaded, by transmitting through the girder a portion of their lifting power.

The most striking feature in the Janicki dock consists in driving the water from the pontoons by compressed air, instead of drawing it out by means of pumps. The pontoons, Figs. 1, 2, 3, resemble the tubular cylinders that are sunk by the pneumatic process. There is no bottom to the pontoon, and the five other sides are made very light, since, in place of having to withstand when the pontoon is sunk, the weight of water corresponding to the submergence, they have only to carry the difference between this amount and the pressure of the compressed air, it may be the weight of a column of water at most equal to the same height of the caisson.

This single alteration permits of a great reduction in the weight of the pontoon. The comparative estimate made by the inventor shows that the economy in weight attains 40 per cent.

The framing of these bottomless pontoons is formed of transverse and longitudinal frames, which distribute the weight when the dock is loaded. Bulkheads divide the pontoons into several compartments, and contribute also to their stability. The length is also divided in compartments, adding considerably to the longitudinal strength.

When the pontoon rises in the water, the compressed air expands; it may be feared that the expansion would not take place equally, and that the water would rush towards the place where it was greatest, and would produce movements likely to cause danger to the pontoon. It was necessary to take care that the air should never escape below the vertical sides of the pontoon, and rising up their outer sides form a column of water mixed with air that would create a dangerous submergence. M. Janicki obtains this result in a very simple manner, by the employment of safety tubes. Pipes, open at both ends, are placed in each of the end compartments, near the lateral sides of the dock. The lower ends of these tubes are a little above the plane of the lower edge of the lateral sides, the upper end being always above the water. If by any cause the level of water in one of the compartments is lowered near the side, below the end of the tube, the air escapes by it without passing under the vertical plate of the dock.

The air forced into the pontoons is compressed by pumps worked by an engine in an independent vessel, and it is led under the pontoons by means of pipes and branches to each of the compartments, every branch being fitted with a valve to prevent escape of air.

To keep the dock afloat when it is empty without being obliged constantly to pump air under the caissons, and also to increase the stability, the pontoons are not without a bottom for the whole length, water-tight compartments being placed on both sides of the dock, as shown in Fig. 1. The pontoons are securely fixed between the transverse double frames, arranged so as to form a single structure, or to be divided into several independent parts. The elevation and plan show these girders continuous from end to end.

Transverse floats, intended always to rest on the surface of the water, in every position of the dock, are movable between the vertical guides of the girders. But the connexion between these floats and the pontoons is not made as in the St. Thomas's dock, by screws or other arrangements worked by special engines. The floating boxes are automobile, that is to say, that the relative positions of the floats and the pontoons vary unassisted, as the dock rises and falls, the motive power which produces these movements being a part of the weight of the dock, or its rising force. But it is of course necessary that each of the floats should

move alike with regard to the pontoons, to the end that the dock may remain horizontal as it rises or falls; it is needful, then, that these floats should be dependant upon each other either along the whole length of the dock, or in each of the sections of which it is composed, because this connexion alone is able to insure the stability of the dock.

To effect this each of the floats is attached at both ends to an endless chain passing over two fixed pulleys, the one above the other below, the main girder; the upper pulleys are placed in communication in each section for the whole length of the dock. Amongst the numerous ways of effecting this is the means shown in Figs. 1, 2, and 4. The upper pulleys are connected by endless chains passing over pulleys mounted on two shafts placed on the upper side of the pontoons, and of the entire length of a section of the dock. There remains, then, only to connect together the shafts in such a way that they revolve in unison, but in reverse directions. This is easily done by the aid of a transverse shaft, on which are placed two pinions driven by bevelled spur wheels, the shafts of which are put in relation with the principal shafts.

Transverse stability is thus obtained, since if the pontoon inclines on one side the floats on that side sink, and on the other they emerge, forced as they are to keep in the same relative position to the pontoons, as the ones on the other side. There are thus produced two forces tending to equalise the dock. But the longitudinal stability results also from this connexion of the floats in such a manner that each section of the dock shall have a certain stability. If the dock is composed of independent sections, the pontoons will find their respective levels, each being horizontal, and sinking more or less according to the load it supports.

The advantages M. Janicki hopes to obtain beyond the economy of construction resulting from the reduction of weight, are the following:—The handling of the dock is more rapid, more easy, and more economical, since there is less dead weight to move, and it is sufficient to force air into the compartments of the pontoons without any trouble in working the floats by the help of special machinery. The transverse and longitudinal stability is well secured. The ventilation is better than in the dock with close compartments, and consequently the drying of ships under repair is more rapid. The construction of the dock is easy, because it is formed of a series of similar parts, of which each is easily accessible.

There is reason to hope that the application now being worked out will permit the realisation of improvements proposed by M. Janicki, and that this form of floating dock will be found less costly in construction, more economical in working, and more satisfactory in practice than the more complicated system it is intended to replace. We may add that it will be possible in this form of dock, as well as in some of those actually in use, to interpose between the ship to be lifted and the pontoons forming the platform of the dock a flat, capable of supporting the ship in such a way that, after the raising is accomplished, the vessel can be taken out of the dock, inspected, and repaired, so as to render the dock disengaged for other vessels.

It is to be hoped that the economical advantage of this form of dock will tend to an increased use of these useful appliances. At present the number of floating docks is very small, ships have often to travel far for repairs; and, when they arrive, may be obliged to submit to a longer delay until the dock is free.

To-day, when steam is so rapidly superseding sails, and speed is a matter of the first importance, any means which will render frequent inspection and clearing of the hulls of vessels below the water less tedious and costly will prove of great utility to commerce.

THE BERWICK WATER SUPPLY.

We are indebted for the following description of the new water works, now in course of construction at Berwick-upon-Tweed, to Mr. D. Manuel, who is in charge of the undertaking. We may state that these works are to supersede those constructed by Mr. Rawlinson about 1852, and the supply from which has been long insufficient:

The works are situated at the Old Tower Foundry, the water springing from the rock in the site of an old quarry immediately at the back of the buildings, where a pond had been formed for the purpose of storing the water which was used for driving an overshot wheel, acting on a turning lathe and blast for furnace. The springs in the quarry, together with the lower spring, will give about 220,000 gallons per diem, and, for the purpose of storage, a tank has been constructed, 80 ft. long by 50 ft. wide, and 8 ft. deep to top of cope. In forming the tank all the rubbish has been cleared out of the quarry, and the rock excavated to a uniform level. The wall next the lower tank, through which the outlet pipes are taken, is of ashlar and rubble masonry, set in hydraulic mortar, and puddled at the back, but the back and side walls are of dry rubble masonry, so as to retain the banking and allow the water to find its way into the enclosed space. The lower tank occupies the position of the old moulding or casting shed, and is built of ashlar and rubble masonry, set in hydraulic mortar, and paved in the bottom with Caithness flags set on a layer of concrete. In this tank, which is 70 ft. long by 20 ft. wide, the suction pipe is placed, communicating with the pump. The water from the upper tank will be conveyed to the lower by a 9 in. cast-iron pipe, having a branch connexion with the suction pipe, so as to turn it on to the pump by means of necessary valves without entering the tank. The lower spring will have a separate inlet to the tank with valve and bye-pass pipe. The engine, boiler, and coal houses are at the west end of the lower tank. The engine and pump are vertical, resting on a cast-iron sole or bedplate in one casting set on a solid ashlar seat, to which it is bolted and keyed down. The fly and spur wheels are over head, the shafts having their bearings on a cast-iron box beam and bedplate on one of the side walls. The beam is keyed into cast-iron boxes built into each gable, and under the bearings of shafts, is supported by two box upright pillars bolted to beam and bedplate. To each pillar is firmly bolted the steam cylinder and pump. The engine is non-condensing, having a 3 ft. stroke, the cylinder being 17 in. diameter, to work with a pressure of 50 lb. on the square inch. A 9 ft. rod connects the piston head and crank-plate keyed on to the end of the fly shaft. The fly wheel is 11 ft. diameter, and on the same shaft is keyed a toothed wheel working into a spur wheel, having a ratio to small wheel of 3 to 1, in diameter, keyed on to the pump shaft. The pump is double-acting, of the bucket and plunger class, the plunger being 13½ in. diameter, and the pump barrel 18-⅝ in. diameter. The velocity of the pump will be one-third that of engine, with same length of stroke. The guides for crossheads of piston and plunger are fitted into the box uprights on one side, and into uprights bolted on the other sides of cylinder and pump. These uprights are braced at the top by a neat cast-iron frame work. The air vessel is 14 ft. 6 in. high, and 3 ft. 6 in. diameter firmly bolted to the end of the bedplate. The rising main will leave the lower side of air vessel, and in the coal house has a clack valve similar to one on the suction pipe before entering the pump. The boiler is single flued, 26 ft. long by 6 ft. 6 in. diameter, resting on two side web blocks, and has an under and two side fire-brick flues, entering main stalk flue through a regulating damper, the smoke being carried off by a square brick chimney stalk 84 ft. high, 7 ft. 6 in. at bottom, battering to 3 ft. 6 in. at top, and having a fireclay moulded cope. The lift from the engine house to high service reservoir is 185 ft., giving a pressure on lowest points of rising main of over 80 lb. on the square inch. The rising main is 9 in. in diameter, mostly all turned and bored in the joints, having all the necessary scours, air cocks, and valves. The connexion with low-service reservoir will have a self-acting ball cock, and the inlet to high service reservoir will be furnished with suitable measuring apparatus to check the inflow. The present average supply is 10 gallons for each person per diem; but when this additional supply shall have been turned on, the gross supply will average fully 30 gallons per day during the driest season of the year.

It is roughly computed that the new works will cost at least 7500*l.*, including the purchase of the foundry property.

THE NORTH SEA CANAL.

Mr. Macgregor, well known as "Rob Roy," is now making a cruise in his canoe on the Zuyder Zee, and he has communicated to the *Times* an interesting account of his voyage, from which we quote the following particulars of the North Sea Canal. He says:

"A visit to the Suez Canal in my canoe (which was related in the *Times* a few years ago) enabled me to compare the North Sea Canal with that larger, more mundane, but not more remarkable example of human industry and patience, cutting the land in two to abridge the seas, levelling whole mountains of sand, battling with deep tides and hidden springs, stormy waves, and thousands of dubious or impatient shareholders—by far the most difficult obstacles for the venturous capitalist and the clever engineer.

"I have already explained that the North Holland Canal, which was cut to save a roundabout from Amsterdam by the Zuyder Zee, is more than 50 miles long, and enables large ships to enter Holland at its extreme northern end. But this canal is too long, too narrow, too tortuous, and too shallow for the increasing length and depth of our largest merchant vessels. To save time, then, and much trouble and transshipment, the new canal opens to the west instead of to the north. It is 15 miles in length instead of 52. Its depth is 26 ft. available instead of 16 ft., and no bends or sudden turns obstruct the passage anywhere. Six years ago this work was begun by the well-known English contractor, Mr. Lee. With Mr. Hawkshaw and Mr. Dircks to plan, and Mr. Freeman to execute, and a wealthy company to pay for it, all good folks ought to expect success.

"At present the work is precisely in that condition most interesting to inspect, being just beyond the state in which any doubt can remain as to ultimate success. Very likely this success will sap the other canal, and reduce Nieuw Diep to a marine depôt: perhaps it will also draw the golden tide from Rotterdam, but perhaps, too, the merchants there will shift their quarters to the better entrepôt of Amsterdam, and yet perhaps, indeed, when all is done a certain German Prince will stretch out his iron hand and ask for the new road, and very graciously thank those who made it for him.

"First of all locks are being placed on the east, to enclose an artificial lake about 12 miles long, at one end of which rests Amsterdam, and a deep channel is dredged along this lake, with two banks gradually rising into solid tow-paths. Minor canals, in all about 12 miles long, are left on either side to communicate with the little towns now on the shores of the Y, but all this intermediate area of water will be pumped out, and so nearly 12,000 acres will thus be reclaimed. No one can say how much this new territory will sell for, but an acre I asked about at random was valued at 100*l.* The average may be one-half of this sum.

"The dredging is far better done than it was on the Suez Canal. The machinery has been steadily improved and simplified, and the latest and best appliance was only completed a few days ago. This consists of a tube resting near the cone at the bottom, and containing a shaft with a centrifugal pump,* which draws up the sand and water bodily—about half of each in the mixture—and forces it along wooden pipes floated on the surface of the water, and flexibly jointed by leather hides. The slush is thus poured through a conduit about 300 ft. long and 1 ft. broad, which resembles a huge black snake coiled and asleep on the water, and with its tail turned over the bank at the side. Through this tail, even when it is raised 8 ft. above the level, a copious fluid rushes, black as ink, but fertile for the next hundred generations of cheese-making Hollanders. So simple is this plan that already it is being applied to the great banks of the Danube, and I saw boxes full of the hide joints being sent to the Sulina mouth. Not many, but still some, curiosities have been found in the ground dug up or dredged for the canal. An enormous mammoth's skull and huge bones of the same fill one end of Mr. Freeman's office, and these ought to be in the British Museum, and could, I believe, be readily forwarded if properly applied for. One human skull has been dredged out 9 ft. below low-water mark, and I am enabled to bring it home. The size is large, the frontal part very small, the forehead being scarcely more than an inch in height. One or two pottery pieces have also been found, and, of course, plenty of shells. As no gravel has appeared in the matter dredged from below, it seems plain that the idea is erroneous which has long suggested that an ancient mouth of the Rhine once led through Holland at this spot.

"The banks thus formed are gradually raised above the surface to the average of 3 ft., and then a layer of stiff clay is placed over the sand. On this is spread a sort of matting of loose reeds, which grow profusely in every lagoon. Long twigs of the willow-like tree, named 'rys,' are then laid down, and stakes about 4 ft. long are driven through them in rows, while a regular-twisted wattling of 'rys' is securely worked into these, and the whole assumes a most business-like aspect, utterly different from the loose, unprotected sandbanks of the Suez Canal, which latter the water, the wind, and their own weight all conspire to ruin. Better than all the rest a plant called 'helm,' which grows naturally on the sand-hills, is being planted like cabbage rows upon the new-formed banks, and this rapidly takes root, and binds all together. This plan is to be tried on the Suez Canal, but probably the climate and the larger proportion of salt water in the Egyptian sand, may prevent the 'helm' from growing there. At the end of the lake we reach the four miles of solid sand and elevated ground which had to be cut through before the western shore of Holland is attained. The deepest cutting is not more than 100 ft., and is a mere matter of digging and carrying away. At length we come to the locks close to the sea. These are of enormous size, 500 ft. long and 60 ft. broad, with a depth over the sill of 30 ft. The stone-work facing of these is beautifully fitted, and the 25,000,000 of Dutch bricks here laid are a model of bricklaying. The width of the canal from centre to centre of the towing path is about 500 ft., but at the edge of the main channel only 200 ft., and 80 ft. at the bottom; but this gives ample room for the largest vessels to pass each other. Now we are in the thick of the 'dunes' or sandhills, Holland's western wall. They are not bare, but rather jungly in their look, and hares and rabbits, and curlew and spoonbills, are plentifully found by the sportsman on these wilds. Climbing this barrier we can look down on the two gigantic pier arms that stretch forth boldly into the stormy sea, and which keeps steadily lengthening every week, and gradually bending in their ends to form the grand entrance to the new-born port. Nearly one-half of these piers is already finished, and this not by casting in the huge blocks promiscuously, as at Port Said, but by placing every one on its proper bed, well-fitted to its neighbours, and bound by iron-ties, so as to form a smooth-faced, upright sea-wall. The blocks thus placed are made of concrete and Portland cement, in weight about 10 tons each, just as at Port Said, and thousands of them are still on the shore waiting to be run along the pier, and then to be hoisted up by the iron neck of the great steam 'Titan' which will swing them into their final beds."

* [This apparatus was illustrated by us on page 134 of our number for the 1st inst.—Ed. E.]

Gathering Electricity with a Walking-Cane.—S. H. Lockett, Professor of Engineering at Louisiana University, writing from Niagara Falls, relates the following phenomenon: "While crossing the upper or new suspension bridge to-day, I had occasion, while conversing with a friend, to point toward the falls with my walking-cane. As soon as I did so, I heard distinctly at the end of my cane a buzzing noise, like that made by electricity passing from a heavily-charged battery to a sharp-pointed rod. Repeating the experiment, the same noise was heard. I stopped several passers, and tried their canes with the same result, except in one case where there was no ferrule on the cane. I immediately supposed this might be an electrical phenomenon, and set to work to test the correctness of my supposition. I took a key, and held it at arm's length toward the falls, and heard the same sound. Finally, at dark, I returned to the bridge, and pointed my cane in the air, and had the satisfaction of seeing a clear, beautiful electric brush on its end. The best point to observe this interesting and beautiful phenomenon is in the middle of the bridge, and the cane must be held at arm's length, so that its end may be at some distance from any part of the bridge. The success of the experiment seems to depend a good deal on the direction of the wind and the amount of vapour blown over the bridge. To-day the wind is strong, and drives the mist directly from the falls to the bridge, but an occasional shifting or lulling of the wind would cause a cessation of the electrical noise or light. My explanation of the phenomenon is this: As Franklin with his kite and key caught the lightning from the clouds of heaven, so here, from the suspension bridge, surrounded by the vapours from the mighty falls, we may stand and gather on our walking-canes the electricity generated by the falling waters and contained in the floating mists. I think suitable arrangements might be made to collect enormous quantities of electricity from these mists, which might be used in producing grand and striking effects, thus adding another attractive feature to the sights at this wonderful place."

COMPOUND MARINE ENGINES.

TO THE EDITOR OF ENGINEERING.

SIR,—For the last twelve years I have been amongst my engineering friends popularising the use of steam coefficients as tests of indicator cards. I cannot allow to pass unquestioned the calculation of coefficient given in last week's ENGINEERING, for Messrs. Richardson's compound engines.

The total ratio of expansion calculated from capacities of cylinders and pressure as cut off in high is eleven times. The coefficient due to such an expansion, and under mathematical conditions, is 1+hyp. log. 11=3.398.

The low card shows a back pressure=1½ lb. The total pressure effective, referring all to low, is given as 16.167. Deducting this from coefficient, we get $\frac{3.898 \times 16.167}{1.25+16.167} =$ 3.154 as the greatest possible result, even under mathematical conditions. If the coefficient were really 3.32, these compound engines would be an advance upon perfection to the extent of 3.32−3.154=0.166, or one-sixth of the total effect of unexpanded steam.

I quite concur in the opinion given of the value of this coefficient test of performance by card, but I am anxious to be contradicted in what I am about to say, that 2.2 is a fair coefficient in compound engines doing good work. I do not believe that 3 ever has or ever will be attained in compound engines at sea.

Common engines give 1.5 when working with about 25 lb. of steam, cutting off at one-third from the beginning. Many compound engines give a coefficient not higher than 1.75, and only a few exceed 2.2, and that only when giving a total effect equal to less than 21 lb. per square inch, referring all to low piston. Many common engines working at about 14 lb., and with little expansion, give a coefficient little above unity, and it is as compared with these that the compound engine shows to best advantage.

The value of this coefficient is that it is a true measure of the work got out of the steam. It is the quotient found by dividing what you get by what you pay. The measure of what you pay is the large cylinder full of steam at a certain pressure, namely, that to which the whole steam for one stroke would expand to fill the cylinder. To get at this we must measure the steam before any of it disappears from the diagram, and the best point to take it at is a little before the exhaust in the high-pressure cylinder. Generally, not always, there is a difference between the actual terminal in low and that due to the volume of steam shown on the high card. We should, therefore, in every case try what the high diagram will give us, and use it, if in excess of the low terminal. But, in returning to the high cylinder, we must avoid the compression corners, or the result will err on the other side.

My rule for calculating the due-terminal pressure is this. Write down the ratio between cylinders—in this case 3.58. Multiply this by twice the length of the card, say, in inches. Set off the product as a pressure above zero on the high pressure diagram. Draw a horizontal line at that height. Measure on this line the lengths of both diagrams from expansion curve to compression curve. The sum of these two lengths in inches is the pressure in pounds due at end of stroke of low piston, if no steam disappears.

If the reader will try this on last week's diagram, he will find that the length of cards is 5 in.—2×5×3.58= 35.8. Deduct 14.7 gives 21.1 above atmospheric line. Draw the horizontal line, and, measuring on that, the one diagram is 3½ in., and the other 3 in., or, altogether, 6½ in. According to my rule, then, the due-terminal pressure is 6½ lb. The length of the diagram need not be measured in inches always; any scale for lengths can be used to bring height of horizontal line to be a little before the exhaust.

In last week's article 4.875 is used as the divisor to find the coefficient instead of this 6.125. Taking the average effective pressures as given on diagrams last week, and dividing by 6.125, we get a coefficient only 2.64 instead of 3.32. But on remeasuring the figures by one ordinate instead of ten (I always use only one), I make the average pressures slightly less, namely, 25.6 on high and 8.5 on low. Referring all to low $\frac{25.6}{3.58} = 7.15 + 8.5 = 15.61$.

And $\frac{15.65}{6.125} = 2.55$, which appears to me to be still a high coefficient, although much below 3.32.

I have given the above rule as I use it, but I should perhaps give it in another form as more easily understood, although not nearly so convenient.

The horizontal line may be drawn without calculation, just cut both diagrams before the exhaust and at compression, or during expansion and compression. Multiply the pressure at this line, above zero, by the sum of the lengths intercepted between the compression and the expansion, and divide the product by twice the length of diagrams. Divide this quotient by the ratio between the cylinders, that is, areas. The quotient is the terminal pressure due to the steam shown on high card.

J. MCFARLANE GRAY.

12, Montenotte, Cork, September 19, 1871.

ERRATUM.—In our description of Messrs. Richardson and Sons' compound marine engines, on page 175 of our last number, the words "and boilers," were inadvertently inserted in the 24th and 25th lines. A self-evident error was also made in the reference to the page on which the engravings showing the general arrangement were published.

RIGHTS OF INVENTORS.

TO THE EDITOR OF ENGINEERING.

SIR,—Your article on the "Rights of Inventors" does not dispel the fog that envelops the question, especially that phase of it that may be considered its defence. And the attacking party, with Mr. Macfie at their head, is treated with scant courtesy.

You seem, if not enamoured with the present system, at least believers in its efficacy. And, but for the occasional incursion of pirates, who you admit can succeed in levying their black-mail, is capable of more good than harm. Well, there are those who believe that the existing system is one of the worst types of injustice, that has not one redeeming grace to commend it to futurity, and that, whether succeeded by any other system of rewards or not, the country would remove one foul blot from its legal escutcheon by its wholesale removal. The highest ground you take for its retention is that merit may meet its reward. This, I believe, is not entirely ignored by even Mr. Macfie; but one of the overwhelming difficulties is to define merit, and to bring the reward home to the really deserving. He is a sanguine man who believes this is done, or can be done, under the patent laws as they exist. Capital ready to be launched into legal contest is necessary to keep the unscrupulous from reaping the reward of merit; and this alone places needy inventors at the mercy of more money-mongers.

But to place the exact bearing or extent of any claim beyond the domain of dispute, is, I fear, a function not to the manner of the present laws. And it is considered by men of unquestionable status in legal and political circles to be impossible to frame any plan the rich and reckless may not ignore. If this should be so—and there are many startling facts to support it—better that the truth should be divulged, and merit seek a sale in unprotected markets. It is a spurious prophecy that the removal of the means by which merit can be dispossessed and the right of property conferred on the undeserving, will dry up the fountains of thought and cut off the supplies of ingenuity. Were it possible by crushing wrongs and distressing discomfiture to effect this,

> "The law's delay, the insolence of office,
> And the spurns that '*patient merit*'
> Of the unworthy takes,"

would have accomplished it long ago. But the power of invention is as much the gift of genius as that of art and literature, and quite as irrepressible; it may be "born to blush unseen," but seldom suffers from felo-de-se. The fundamental principles of science or art were not discovered and fostered under the wing of the patent laws, nor the works of Shakespeare induced by the law of copyright; they spring from irresistible forces in nature, "whose mighty current and compulsive course ne'er feels retiring ebb." Credit for sincerity as reformers is obviously not conceded to the opponents of the patent laws, but their motives are supposed to spring from private chagrin or love of personal profit. But this has ever been the case. What political change has not had its antagonisms tarnished by the same imputations?

Personal interest is often identified with public benefit; it is then no wonder that men armed with courage, and animated by so great a cause, should come boldly to the front, even though the incentives may be doubted. Was not Cobden personally interested in the widest development of free trade? but his labours were not less national nor his purposes less lofty.

In what struggle do you find the most active agents free from some distinct identity that may be termed selfish. This does not mar effort nor frustrate design when a clear national purpose is embodied in the result. It is, then, of small moment that Mr. Macfie and Sir W. Armstrong may find profit by the change, or a source of hindrance cleared away. The one indefensible ground assumed by the patent system embodies the right of public resistance, that is, the granting of monopolies. Public money granted to secure a private end is a political wrong. Of course the assumption is that the public is the gainer. But money should not be given on assumption. There should be a clear and demonstrable benefit to the State. And this is never the case. The sanction of the State is given for good or evil, to work a patent if you like to sell its suppression, and to stand as a stumbling-block in the way of every effort in the same direction for fourteen years. If merit is to be recognised, and I trust it may, it can only be through some medium less exclusive, and where the payment of protection shall confer the right to license on the State that sanctions it. The legal barriers of the present system could not be suffered to stand as they now do in the way of defining a claim if ever merit is to be encouraged in its aid to progress; but this must form the feature of some future communication, if I am permitted to trespass so far.

The defence of the patent laws is not remarkable for its public spirit, but seems rather the fencing of a special order. The papers I have seen on the subject have been from pens more directly interested in the retention of the bewildering fee system, than Mr. Macfie in his opposition. And I incline to the opinion that a few such papers as you published from the pen of Mr. Wise will do more to eradicate the foul abortion than the best-directed efforts of its enemies. For a more unique collection of its "embossed sores" that disgust the public sense could scarce be made, disparaging all hope of human skill restoring it, or aiding it in any way but to a well-merited grave.

CYCLOPS.

September 19, 1871.

[Our correspondent is eloquent but somewhat obscure; we trust that his views upon the rights of inventors may be more clearly expressed in his next communication.—ED. E.]

ENGLISH COAL IN FRANCE.—The total shipments of English coal to France to July 31 this year amounted to 1,047,404 tons, as compared with 1,276,988 tons in the corresponding period of 1870.

NARROW GAUGE RAILWAYS.

TO THE EDITOR OF ENGINEERING.

SIR,—There is in your last week's impression what purports to be a report of a speech made by Mr. Pihl, of Norway, at the opening of the Toronto, Grey, and Bruce Railway in Canada in which the following occurs: "But I must warn against such statements as have appeared in the American papers lately 'that in Russia on the 3 ft. 6 in. narrow gauge railway, some of Fairlie's engines, weighing 20 tons, had drawn 340 tons gross load up an incline of 1 in 80.' Now, every engineer knows that until water runs up hill, the engine has not power to draw more than about half the load stated up a grade of 1 in 80." My first impression on reading this paragraph was that the weight of the engine given was a mistake of some kind or a misprint, but on a perusal of the report I find from the manner in which my name is introduced, that Mr. Pihl's intention was to discredit me, and employed in doing so a statement, which no one knew better than Mr. Pihl, it was utterly impossible I could have made. I am perfectly surprised that Mr. Pihl, generally so accurate and straightforward, should turn traducer of any man's fair fame in a foreign country, where he probably anticipated his remarks would never reach that man's ears. I repeat I am astounded, and from the tone of bitterness in which those remarks were made, it is a happy circumstance for me that from a mass of statements he can only pick out what he says he saw in an American paper, for which I certainly cannot be responsible. There are two reasons why I am sure Mr. Pihl must have known he was misrepresenting me. The first is that he knows I could not, and never have, issued during the whole course of my writings on the locomotive or gauge question, one single statement which can be disproved, notwithstanding the very startling nature of some of these; and, secondly, that he must have seen the report of my paper read before the British Association at Edinburgh, giving the particulars of the working of the Imperial Livny line.

Probably I know how much water will run up hill quite as well as Mr. Pihl does, but if he wants to create a sensation at the next speech he delivers I pray him not to be funny at my expense, or if desiring a joke against the gauge I have made my own, let him take it from the following extract from the *American Railway Times*:

"The narrow gauge locomotives, built by the Baldwin Locomotive Works for the Denver and Rio Grande Railway, have been set up and tried on the line of that road near Denver, and are now in operation in the construction of the road. About 3½ miles of narrow gauge track (3 ft.) had been laid out of Denver at last accounts, and upon this the small engines have been thoroughly tested. Immediately upon leaving Denver the track is laid to a temporary grade of 140 ft. to the mile. Up this grade the freight locomotive pulled twenty of their four-wheeled flat cars loaded with railroad iron. The engine hauled this train without difficulty, stopping and starting readily with it on the grade. This engine has three pairs of drivers 30 in. in diameter, a 'pony truck' in front, and weighs, in running order, 34,000 lb.

"The passenger engine, 'Montezuma,' (with two pairs of drivers and 'pony truck,' weight 25,000 lb.,) drew a train of six passenger cars, at a speed of 30 miles an hour, making the time with ease. The engines ride well and steam freely. We are permitted to print the following letter from General Superintendent and Chief Engineer Greenwood, who has charge of the construction and operation of the line:

"Denver, Colorado, August 12, 1871.

"Messrs. M. Baird and Co.:

"Gentlemen.—This is to certify that your engineer has delivered to the Denver and Rio Grande Railway the three engines constructed for them by your company. The engines, as far as they have been used, have proved a perfect success, and I fully believe they will perform all the work they were guaranteed to perform. I have always had full faith in the success of the narrow gauge (3 ft. in this case), and the working of the engines as well as of the other rolling stock, which we now have on hand, fully demonstrate that we were justified in reducing the gauge on our road.

"Very truly yours,
(Signed) "W. H. GREENWOOD.
"Gen'l Sup't and Gen'l Manager."

I am, Sir, your obedient Servant,

R. F. FAIRLIE.

9, Victoria Chambers, Westminster, September 21, 1871.

HOT GASES.

TO THE EDITOR OF ENGINEERING.

SIR,—About 25 years ago I took out a patent for "Hot Gas" and made some elaborate and exhaustive experiments to ascertain its value and economy in practical use; the gas was heated by reducing a copper tube ¾ in. to an oval section, and passing it over its own flame just near enough, only to escape deposit of carbon. The temperature could not be less than 400° to 500°; but this I did not ascertain. The trials were made with bat-wing, fish-tail and argand burners; I found no practical economy when the pressure on the apertures of the burners reduced the flame to its proper and ordinary size, that is to say, if the nipple was consuming coal gas at the rate of 5 ft. per hour, only about 3 per cent. was saved when the same quantity of gas was being consumed in a heated state and with the same sized flame.

If, however, the gas passing through the nipple was flickering or roaring when cold, I soon found that, as soon as it became heated, the flame gradually assumed a steady, bright, and brilliant form, and gave a shadow by from 25 to 30 per cent. better light for the same quantity of gas consumed; the same happened with either of the open burners, and in the argand, if the flame with cold gas was yellow and on the point of smoking, I found that as the gas got gradually hot, the flame was reduced in height and its brilliancy increased fully 25 per cent.

The conclusion I arrived at was, simply, that a much larger quantity of gas could be consumed, (by extra flow or

pressure,) with the same burner, in a heated than in a cold state; there is no doubt that hot gas more readily combines with the oxygen of the air, meeting it as it does, ready for immediate combustion; hot gas, therefore, will be useful where light only, and not economy in use, is the object sought for.

M. Janssen says (see your No. of 8th inst. p. 166) that "at 7.35 the sun rose, the air cooled rapidly, and the thermometer fell from 30.20 to 19.40°." Now does not this go far to prove my theory, that the sun's rays are not hot, to be correct; for in passing through the air they actually reduced the temperature 10°, they absorbed all the heat they could, or in other words gave out their cold. It seems paradoxical if not absurd to say a bath or shower of hot sunshine suddenly produced a temperature 12° below freezing (radiation or evaporation is not a satisfactory explanation). The sun's rays produce their maximum heat only when they are suddenly arrested and strike point blank a resisting medium; when they pass onward, as through glass, ice, &c., they carry with them their heating powers, and whether the sun be or be not a "ball of fire" the heat he radiates is lost long before his rays reach our place in the heavens.

I am, Sir, yours truly,
S. W. Smith.

CENTRIFUGAL DREDGING MACHINERY.

To the Editor of Engineering.

Sir,—We observe in your issue of the 1st inst., on pages 133 and 134, a description and engraving of centrifugal dredging machinery, said to be invented by Mr. James Burt, of Velsen, North Holland.

We beg to inform you that this machinery, with but slight variation, is our invention, and is manufactured by us.

We are, Sir, your obedient Servants,
Gwynne and Co.

Essex-street Works, Strand, September 8, 1871.

BREECH-LOADING ORDNANCE OF THE MIDDLE AGES.

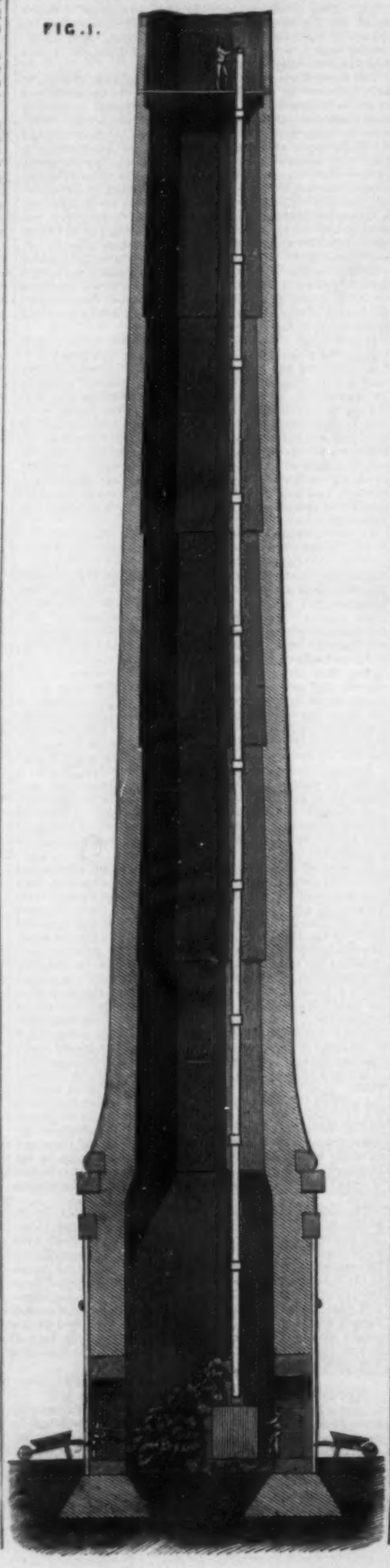
On Monday last a most interesting consignment arrived at the Royal Arsenal, Woolwich. It consisted of three bronze guns, manufactured evidently at an exceedingly early date, although in a most perfect state of preservation as regarded the various parts, and which were forwarded from Portsmouth by Admiral Milne, to whom they had been sent in transit from Rhodes by Her Britannic Majesty's consul. We understand that a considerable amount of correspondence has taken place with reference to these and some other guns of a like nature, which were accidentally discovered by a diver at the bottom of the sea near Rhodes, and were at the time being sold for the sake of the metal which was contained in them, with a view of melting them down. Fortunately, however, this was arrested in time. These curious specimens of warlike constructive art are supposed to belong to a period anterior even to the date of the battle of Crecy, when guns are said to have been first used. But the great interest which attaches to them is contained in the fact that two of the number are breech-loading pieces of ordnance. These are about 5 ft. in length, and would contain a ball from 4 to 5 lb. weight. At the breech end is a chamber, sufficiently wide and deep to contain a large vent-piece, which can be lifted in and out by means of a handle. This vent-piece is not solid as in the Armstrong gun, but has a space hollowed out within it evidently intended to hold the cartridge. Whether the ball formed part of the cartridge with the powder, or was rammed in afterwards at the muzzle, cannot be ascertained, but as the calibre of the barrel is greater than that of the chamber, it would appear that the latter surmise is correct. A plug passing through the breech of the gun and through the solid end of the vent-piece kept the latter in its place when the charge was fired, but there is an orifice in the cascable of each of the guns which may have contained a breech-screw. But the material is so much eaten away that it would not be possible to determine whether there had been a thread upon the orifices or not. The vent-hole is at the side of the vent-piece handle, and so contrived as to be exactly upright when the plug is in its place. On the trunnion piece of one of the guns is the figure of a lion with wings. In a similar position on the other is a human figure apparently holding a book. But the carving is so nearly obliterated that it is difficult to distinguish whether these images are human or otherwise. Such was the breechloader of probably the fourteenth or fifteenth century. Perhaps one of these days we shall be digging up the portable field telegraph which was used by Pharaoh in keeping up a communication with his base of operations when pursuing the Israelites! The third gun, which was received yesterday, is an ordinary-looking weapon, somewhat similar in shape to those which were used in the last century. It has a bore of 3⅞ in., measures about 9 ft. in length, and is also of bronze, but does not bear the same stamp of antiquity as the rest.—*Standard*.

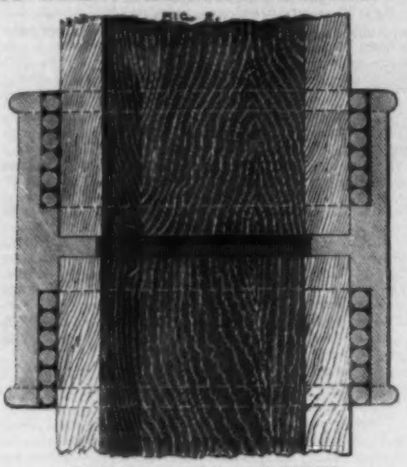
Harwich Harbour Defences.—Some extensive alterations at Languard Fort, the main defence of the entrance to Harwich harbour, are about to be carried out by the War Office authorities. Among other improvements it is intended to build a pier at Languard for the purpose of disembarking stores, &c., the means of approach by land being most circuitous. The total cost of the new works contemplated at Languard will be about 60,000*l*.

An Underground Turkish Railway.—A concession has been obtained for a short underground railway betwen Galata and Pera to be worked on the pneumatic system. The promoters intend to commence the tunnel at once; there will be two or three intermediate shafts for light and air. The Galata station will be in the Rue Voivoda, and the outlet at Pera will be in the Rue Kibristan near the municipal buildings. The transit will be effected in two or three minutes, and at very frequent intervals during the day.

TAKING DOWN A CHIMNEY AT THE TEES IRON WORKS.

FIG. 1.





TAKING DOWN CHIMNEYS.

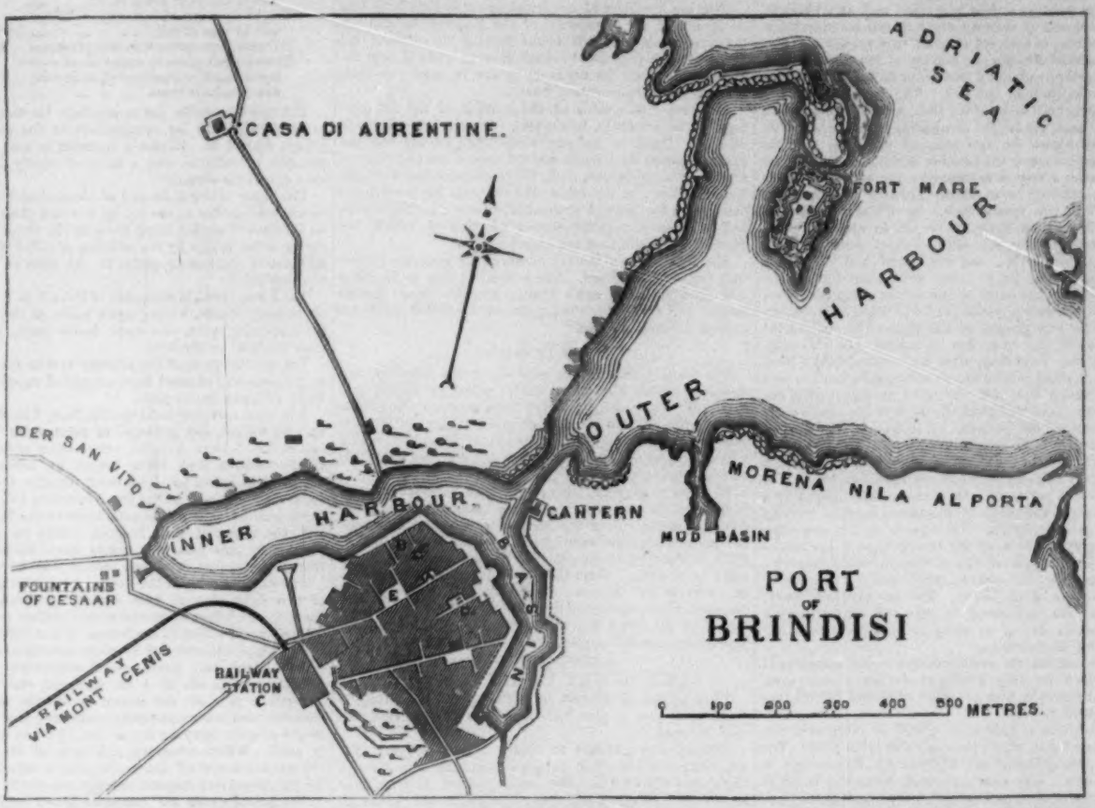
We annex engravings showing an ingenious arrangement for facilitating the taking down an old chimney shaft which was employed some little time ago at Messrs. Gilkes, Wilson, Pease and Co.'s Tees Iron Works, Middlesbrough, and which was designed by the engineer of the works, Mr. Charles Wood. In consequence of the chimney shaft on which this arrangement was employed, standing in a crowded position, the plan of letting it fall was inadmissible, and it had to be taken down from the top. The question to be dealt with thus was, how to get the bricks down with as little damage as possible so that they might be used again for building purposes? Owing to the position of the chimney the bricks could not be thrown down outside, while, if thrown down inside they would have been smashed, or if lowered by mechanical means the process would have been very tedious.

Under these circumstances the question was considered whether the bricks could not be allowed to fall by their own gravity; but at the same time be cushioned sufficiently to break their fall and prevent damage. In order to do this an air-tight iron box was placed at the bottom of the chimney as shown in the section, this box being fitted with an air-tight door, mounted on hinges and closing on an india-rubber face against which it was tightened by a wedge. A wooden spout was then fixed on to the top of the box and carried up to the top of the chimney; this spout was 3½ in. by 5 in. inside and was made of planks 1½ in. thick well nailed together, with a little white lead on the edges, thus making the spout perfectly air tight. The spout was made in about 12 ft. lengths, and these were joined together by cast-iron sockets or shoes as shown in the detail view, and caulked round with tarred yarn—the whole apparatus costing but about 6*l*. A few stays were put inside the chimney to keep the spout steady, and steps were nailed upon it by which the men could ascend. It will be seen that the whole of the spouting being perfectly air tight, if a brick filled the spout perfectly it would not descend; but as the section of a brick is 3 in. by 4½ in. and the spout was 3½ in. by 5 in. there was a ½ in. space each way through which the air could pass the brick freely, this space further allowing for any irregularity in the size of the bricks. The result was, that the bricks being partially cushioned in their fall, arrived at the bottom without any damage whatever. As soon as the box was full the man at the bottom rapped on the spout as a signal to stop, and then opened the air-tight door and removed the bricks which had come down. This being done he again shut the door and signalled to the man on the top to go on again. The man on the top lowered his own scaffold, and as the spout got too high he cut a piece off with a saw. If there was much mortar adhering to the bricks, it was knocked off before putting the latter into the spout, and it was allowed with any little pieces to fall inside the chimney and was wheeled out. The plan we have described is, we believe, quite new, and it is certainly most simple and ingenious. There are no doubt many circumstances under which it might be advantageously employed.

Coal in India.—Coal has been discovered in Rajpore and Kummun, in the territories of His Highness the Nizam. Miners have been sent to ascertain the extent of the seams.

American Steamboat Boilers.—A prominent citizen of New York writes, that the boilers of few of the Sound and North River steamboats and of the ferry boats will bear inspection. Letters from New Orleans and the principal towns along the Mississippi assert that the recent explosion of the boilers of the Ocean Wave at Mobile may be repeated any day. Inspector-General Belknap is expected to issue shortly a series of stringent instructions under a recent Act of Congress, and local inspectors will be directed to subject the boilers of all steamboats in their respective districts to the most careful scrutiny.

THE HARBOUR OF BRINDISI.



BRINDISI illustrates in the present day two of the most marked characteristics in the rise and fall of primary positions with reference to war and commerce; it was the chief port of the Cæsars, whose fleets were built and equipped at Brindisi for their frequent attacks upon Greece, and to-day it is the chief and most desirable point for the chief material interest to two of the greatest important empires in the world, England and India; in fact, it is the turning point where associations of the West must end and those of the Eastern world commence, and is all but home to the wearied Indian, or still further removed Australian. Brindisi anciently marked the termination of the Appian Way from Rome by the two monuments or columns on the heights above the harbour, which were probably surmounted by beacon lights, though this is conjectural; they are 65 ft. in height and are composed of eight blocks of various cippolino, and are ornamented with figures of two of the Latin Gods, one which guards the sea, and the other the city. On the base is the following inscription:

XILLVS FISPIVSALTIB . ATQ. REFVLGT
PTOSPAT ALVPVSVRSMHANE ST VXITA
QVAM IMPERATORE. SMAGN . . .
IPTLIO : BENI GI . . . I. . . .

Here Virgil was born, and his house is still shown, though not carefully preserved. There is also an ancient castle of Frederick II., who derided the Pope. The ancient wall of the city still remains, but many of the old churches have fallen into ruins, the effect of earthquakes. The ancient city of Brindisium is mentioned by Herodotus in the fifth century B.C., as having been founded by a colony of Greeks (Etolians). The port was considered of great importance in those days, being so conveniently situated at the mouth of the Adriatic; it naturally drew to it the commerce of all that part of Italy and the Mediterranean. The port now consists of a most commodious inner and outer harbour, with deep water up to its walls, the large steamers of the P. and O., the Austrian Lloyds, as also those of the Italian Society for the Navigation of the Adriatic, being moored in front of the line of buildings. The port is easily made in all weathers, and is perfectly secure from all westerly gales, while the country at its back is picturesque and fruitful. The railway station is unfavourably situated, being on a high level above the port, rendering it difficult to bring lines down to the wharf for the goods traffic, which, as the trade of the port increases, will become a measure of necessity.

We are indebted for the above illustration and particulars to our correspondent Mr. George Latham, of Trieste.

GERMAN PETROLEUM.—Petroleum, it is stated, is now being obtained at various points in Germany, and operations have been undertaken to bore at unusual depths for this valuable mineral oil.

NOTES FROM PARIS.

PARIS, Sept. 18, 1871.

SEWAGE OUTFALL.

AMONGST the questions with which the Municipal Council of Paris is occupied at present, is one of great importance, and with which our readers are already acquainted by an article which appeared in these columns on the 9th of June last. It is the question of the discharge of sewage waters. The Prefect of the Seine has recently proposed to the council to prolong for several years the lease of the depôt of Bondy. It is, as is known, at this depôt where the larger part of the solid and liquid sewage is discharged, to be there transformed into poudrette and into sulphate of ammonia. The council clearly foresee that in prolonging this lease they insure the continuation of the existing system, the inconveniencies of which are so strongly felt by the population of Paris, and also by the inhabitants of the localities around the centre of infection established at Bondy. Before proposing to the council any definite decision, the commission intrusted to examine the matter has wished to examine the numerous schemes proposed during recent years to improve the condition of outfalls. Accordingly, the commission has examined many inventors, competent practical men, the syndicate of sewers, and the representatives of the common depôt at Bondy. It has wished to know, also, what has actually been done during several years past in the plain of Gennevilliers for the utilisation of sewage water, and it has found that there exists in these prolonged experiments, and in the success already established, a fair hope that before long the Seine may be cleared of all the sewage impurities, and that they may be employed, to an extensive degree, in the fertilising of poor lands.

If the sewers ceased to discharge into the Seine there would remain no objection to their receiving all the house drainage—an advantage which would put an end to the barbarous system of house sewage discharge now practised.

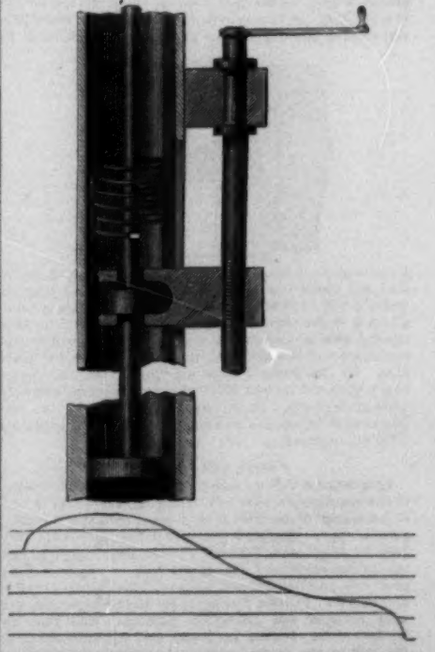
The commission, convinced of the intimate connexion which unites these two questions, has not adopted the contract that was proposed to it, and has resolved to study more deeply the different processes of sewage utilisation before taking any actual step in the matter.

Already the new Municipal Council has given on several questions of administration, proofs of liberality and independence. This new example permits us to hope that it will learn to quit the paths of routine, and that it will aid the city of Paris in the progress and improvements of which she has so much need.

STEAM INDICATORS.

M. Deprez, a young engineer of merit, who is already well known by several mathematical investigations on the distribution of steam, who has invented an expansion gear and a simple and ingenious method of calculation for ascertaining the principles of distribution, has just presented to engineers and contractors a new type of Watt's dynamometric indicator, which shows a real improvement on the well-known apparatus.

It is known that when the speed of the engine to be examined exceeds 60 revolutions per minute, the piston of the indicator is thrown beyond the point corresponding to the maximum pressure of the steam owing to the inertia of the moving parts, piston, piston-rod, and spiral spring



which produces the effect of acquired speed. This cause of error is diminished by constructing the piston and rod of aluminium, and by reducing as much as possible the mass of the parts; but the curves traced by the indicator or engines at high speed, and particularly on locomotives, pre-

sents, nevertheless, at the points corresponding to the commencement of full admission, an irregularity which detracts from their exactitude, and diminishes their value.

M. Depres employs a most ingenious, and, as we believe, a quite new means of entirely avoiding this inconvenience. The spiral spring is enclosed as usual in a cylindrical tube, having a vertical slot for the passage of the pencil-holder. Below the spring is placed a horizontal forked piece which enters the tube through the slot. The piston rod, which passes through both arms of the fork, carries between them an enlarged part, the height of which is a little less than the distance between the two arms of the fork. By the aid of an outside screw the position of the fork can be regulated in such a way as to compress the spring up to a point corresponding to a certain pressure of steam, for example, 40 lb. per square inch. It will be easily understood that if such an indicator is put in communication with a steam cylinder, the piston cannot move until the pressure reaches 40 lb., and the pencil will describe a straight line on the paper rolled around the drum of the indicator. If in one point of the stroke the pressure exceeds 40 lb., the piston yields, and will begin to move, but as soon as the enlargement of the piston rod reaches the upper branch of the fork, this movement will also stop. The pencil will trace then, after having described a horizontal line, a small portion of the curve, then another part of the horizontal line, and the point of departure of the portion of the curve will mark the point in the stroke when the steam reached the pressure of 40 lb. It is sufficient, while the engine is in motion, to turn the screw, and thus to give movement to the fork in the vertical slot of the tube, to obtain as many points as are wished corresponding to the different pressures. On joining these points by a continuous trace, the curve of expansion is given without any error or irregularity. The sketch on the preceding page will give an idea of the arrangement of the instrument, and the diagram of the manner in which it works. Experiments show that one can obtain easily a dozen well-indicated strokes of the piston. The inventor even leaves the pencil of the instrument to pass and repass three or four successively during as many revolutions without the tracing losing its clearness.

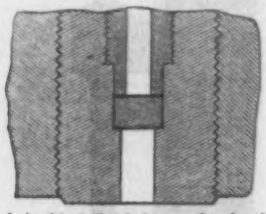
M. Deprez applies the same principle to the measures of pressure which are only developed during a very short time, as, for example, that of gases produced by the explosion of powder.

A series of little cylinders are placed in communication with the chamber in which the explosion takes place. The pistons in these cylinders are adjusted by the springs to given pressures. The exact moment when one of these pistons begins to move gives the pressure of gas at the time.

This adaptation will probably prove of considerable service in the study of explosions, and particularly for observing the pressures developed in guns at various instants of the combination of the powder.

Gunpowder Gauges.

Apropos to this subject the following is another new means which was employed during the siege of Paris, with the object of ascertaining the maximum of this pressure in the new piece of 7, by M. le Commandant de Reffye. The process is based on the investigation of M. Tresca on the flow of solids. A bronze cylinder pierced with a round hole was screwed into the chamber of the gun (see sketch). In



a recess made in this drilled hole was placed a thick disc of lead, and above this was screwed a small steel plug, in which a hole of small diameter was drilled. The pressure of gas from the explosion caused the disc of lead to flow through this opening in the steel plug, and the flow extended more or less according to the intensity of the pressure. By this means it was ascertained that in certain heavy guns, the interior initial pressure sometimes exceeded 4000 atmospheres. In the piece of 7, thanks to the employment of compressed powder, the pressure did not exceed 1800 atmospheres.

Alsace and Lorraine.

In a recent article we called the attention of our readers to the consequences that will follow the cession of a part of Alsace and of Lorraine from a commercial and industrial point of view. A special convention has since some time been in preparation between Prussia and France to ease the transition between the actual rate of import in these provinces, and the definite situation which the annexation will impose. Prussia, fearing to see her markets inundated with Alsacian and Lorrainian products, asks that the freedom of introduction in France may be continued up to the end of the present year, that they may be admitted there for six months at one-fourth duties, and then for a year at half rates. She offers in exchange reciprocity for French merchandise intended for consumption in the annexed provinces, and an anticipation of the evacuation of six French departments, occupied by 30,000 men, and which ought, by the terms of the Treaty of Peace, only to be liberated on the payment of the fourth half milliard.

Now the President of the Republic not having been able on the eve of the prorogation of the Assembly to conclude the arrangement, submits to the deputies the basis of the treaty that he proposes to conclude with Prussia, and demands from them the necessary power to ratify, in their absence, this supplementary treaty.

This proposition, made at the moment of the adjournment of the Assembly, has caused, naturally enough, much emotion. Opinions are very conflicting; on one side the desire to hasten the liberation of the French soil and to avert an industrial crisis from their fellow-countrymen violently denationalised; on the other side the fear of involving a sacrifice on the part of the cotton spinners of Normandy and of French metallurgists—a sacrifice of which the whole country will bear the consequence.

The Assembly on Saturday decided to pass the project with some modifications. The cotton and iron of Lorraine will thus probably enter France free for three months longer, and will enjoy the benefits of a reduced tariff for another eighteen months.

Trade Prospects.

The general situation is good for trade, industry, and finance. Orders abound in Paris; prices of metals and coals hold firm; railways give high receipts. The funds steadily rise, the spirit of enterprise is awaking, on all sides new projects are talked of. The city of Paris loan, which will be put out the 26th of this month, gives rise already to active negotiations.

But this vitality and this energy will be submitted to a rude proof in proportion as the new taxes come into force. Amongst other things the tariffs for travellers on boats, railways, and public carriages will be increased from the 15th of October by one-tenth. Already the new postal tariff is at work. From the 1st of January will be taxes on carriages and horses. As for the tax on matches, in its application the executive power appears to hesitate by reason of the difficulties in carrying it out, the details of which were not anticipated.

THE MOUNT UNION BRIDGE.

This bridge, illustrated in our two-page engraving, is constructed upon a plan known as "Pettit's stiffened triangular truss."

The object sought was to obtain a form of truss, self-adjusting, economical in principle, and simple in the arrangement of its parts. The ordinary form of triangular truss fulfils the first of these conditions, but although theoretically economical in principle it does not prove so in practice. Practically, a form of truss with vertical compression members and inclined ties and counters, is constructed most economically, and Mr. Pettit proposed that a form of triangular truss should be adopted, as here shown, with vertical and inclined members. Under a uniform load the vertical members sustain compression and the inclined members tension, not necessarily the maximum strains, however, which, except for the end members, occur under certain conditions of the variable load.

Under the action of the variable load certain inclined members sustain compression and certain vertical members tension, but the amount of such strain is not very great, especially in large spans where the dead weight of the bridge plays an important part, and it is easily provided for by constructing such vertical members to resist tension and such inclined members to resist compression, the vertical members requiring no more material than needed under maximum compressive strains, and the inclined members only a small amount more than required for maximum tensive strains. To further induce economy of construction and simplicity of details, the angle of the inclined members from the vertical is taken at about 45°, and a single intersection system is adopted, thus massing the material as much as possible. In a bridge of long span, however, by this arrangement the triangles become quite large, the inclined braces are long, and for a deck bridge the upper chord is left for too great a distance in each panel unsupported.

A secondary system has therefore been introduced, consisting of a light vertical post and an inclined panel stiffener, the two connecting with the inclined main carrying braces at its middle point, thus shortening and stiffening it for compression, and at the same time effectually trussing the upper chord for the length of one panel. In case of a through bridge the lower chord would be trussed instead of the upper chord. The structure is designed as a double track deck bridge, of three trusses, the trusses being so placed that when both tracks are loaded, each truss carries one-third of the total load. It is constructed entirely of wrought iron, except certain connecting pins, which are of steel, and the rollers under bolster blocks at the ends of the trusses, which are chilled castings. The different members are joined together by pin connexions throughout.

The following are the principal dimensions and data:

Number of spans over river	4
,, ,, ,, ,, canal	1
Length of spans, centre to centre of end posts:	
One span	121 ft. 6 in.
Three spans	125 ft. 6 in.
One span (canal)	125 ft. 4 in.
Number of trusses in each span	3
,, ,, main panels in each truss ...	8
,, ,, sub ,, ,, ,, ,, ...	16
Height of truss centre to centre of chord pins	15 ft. 8 in.
Height from top of masonry on bridge seat to centre of lower chord ...	... 9 in.
Height from top of masonry on bridge seat to base of rail	18 ft. 5⅝ in.
Distance from centre to centre of trusses	9 ft. 6 in.
Extra length given to upper chord over lower chord for camber = $\frac{1}{10}$ in. in each sub panel = in truss	1 in.

The ultimate strain per square inch for tension is taken at 60,000 lb., and for compression in the case of short prisms, 36,000 lb. Gordon's formula is used in the computation of columns, and a factor of safety of 6 adopted throughout the structure.

The upper chord is formed of channel and deck beams, connected together at the top by a rolled plate rivetted on, an increase of section being given to the chord towards the centre of the bridge by the addition of rolled plates on top, and also of thickening plates to the sides of the webs of the deck beams.

The lower chord is composed of links 5 to 7 in. deep and of varying widths, having upset heads at the ends drilled for connecting pins, the upset heads being ½ in. thicker than the body of the link.

The vertical posts of the primary system are constructed of I beams and channel bars, connected together and stiffened as shown in the plate.

The main carrying links are flat bars, 6 in. deep, and of varying widths, and arranged in pairs, those towards the centre, which have to resist compression under the action of the variable load, being braced by internal diagonal bracing and joined by rivets with distance ferrules. The ends are upset and drilled for connecting pins, the upset being ½ in. wider than the main body of the link.

In the centre of their lengths, where the intermediate connecting pins pass, the braces have thickening plates rivetted on so that the proper section shall be maintained.

The vertical posts of the secondary system are composed of two light channel bars, braced by internal diagonal bracing, and joined by rivets with distance ferrules. The inclined panel stiffeners are formed of two rolled links 3 in. wide, bulged and stiffened by rivets and distance ferrules.

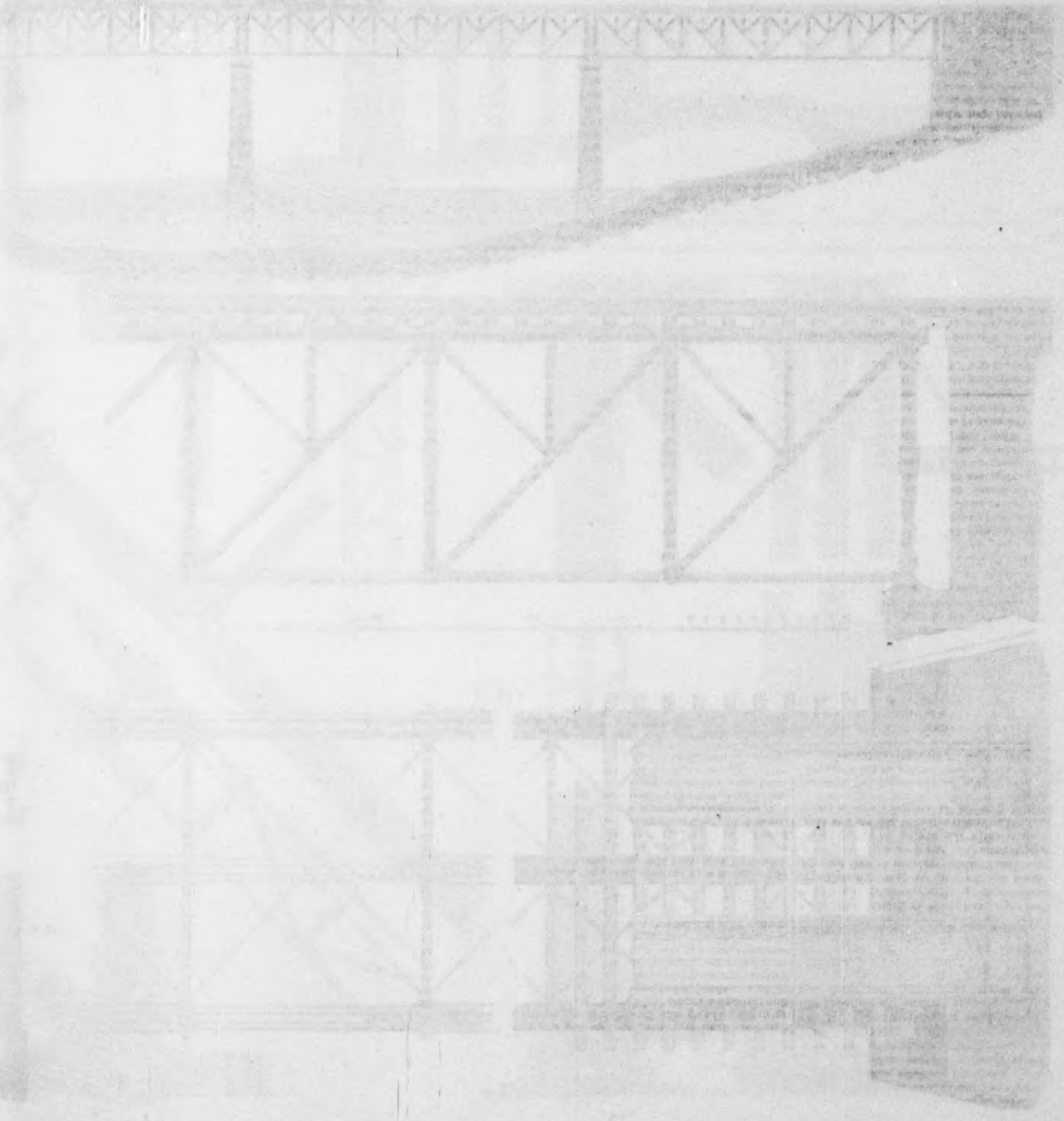
The upper and lower chord connecting pins of the primary system are all 4 in. diameter, the upper chord connecting pins of the secondary system are 1½ in. in diameter, and the intermediate connecting pins in centre of length of main carrying braces are 1½ in. in diameter, and of steel. Where necessary, the ends of the pins project out and are planed off flat on the sides to afford connexions for the lateral and diagonal bracing and struts.

The lateral struts are composed of two pieces of rolled iron, bulged and stiffened by rivets and distance ferrules. The lateral and diagonal bracing are of round rods with sleeve nuts for adjustment. The upper lateral bracing is between the centre and side trusses and in sub-panel lengths. The lower lateral bracing has the rods pass from outer truss to outer truss, above and below the lower chord of the centre truss. The struts are between the centre and side trusses as in the upper chord. Diagonal bracing is placed at every post in the primary system, and in the two central panels only of the sub-system. The latter is merely useful for stiffening the main carrying braces and is formed of light rods, the struts for the intermediate pins being made of two pieces of light T-iron bulged and stiffened by rivets and distance ferrules.

The bolster blocks and pier plates are of wrought-iron, constructed under the Wilson patent, and the former have hinge connexions with the trusses, allowing of adjustment of position. Each truss is fixed at one end, the bearing blocks at the fixed end, and the rollers at the other being chilled castings.

Thickening washers are used on all connecting pins wherever necessary to make all joints snug and tight. It may be interesting to state here, that the Pennsylvania Railroad Company have been steadily renewing their wooden bridges with iron as rapidly as necessary, and that at the close of the present season there will be on the main line between Philadelphia and Pittsburg 15,970 ft. lineal of double track iron bridging, and only 4530 ft. lineal wooden bridging. Of the latter 3682 ft. are of one bridge, that over the Susquehanna river at Harrisburg.

Shipbuilders' Strike on the Clyde.—This strike still remains *in statu quo*, with this difference, namely, that the employers are showing some disposition to resort to serious measures. There are still on the strike-roll in the Glasgow, Partick, and Govan districts about 340 men, some 600 or thereabouts having found work in other shipbuilding ports or at other branches of business. Evidence of prospective action on the part of the masters is seen in the following excerpt minute of a meeting of the Clyde Shipbuilders' and Engineers' Association, held on Monday last in Glasgow: "The meeting, taking into consideration the continuance of the carpenters' strike in the Glasgow district, notwithstanding the advance of wages offered; while at Greenock and other places they are at work; and that such a condition of matters is likely to prolong the strike in the Glasgow district—it was the unanimous opinion of the meeting that a lock-out of all the carpenters on the Clyde should take place in the event of a continuance of the strike." The advance requested by the men was 5s. per week: in only one or two instances has that been granted. It is to be hoped that the dispute will soon be brought to a termination, as there is some fear that a general lock-out may take place in all the shipbuilding yards and marine engine shops on the Clyde.

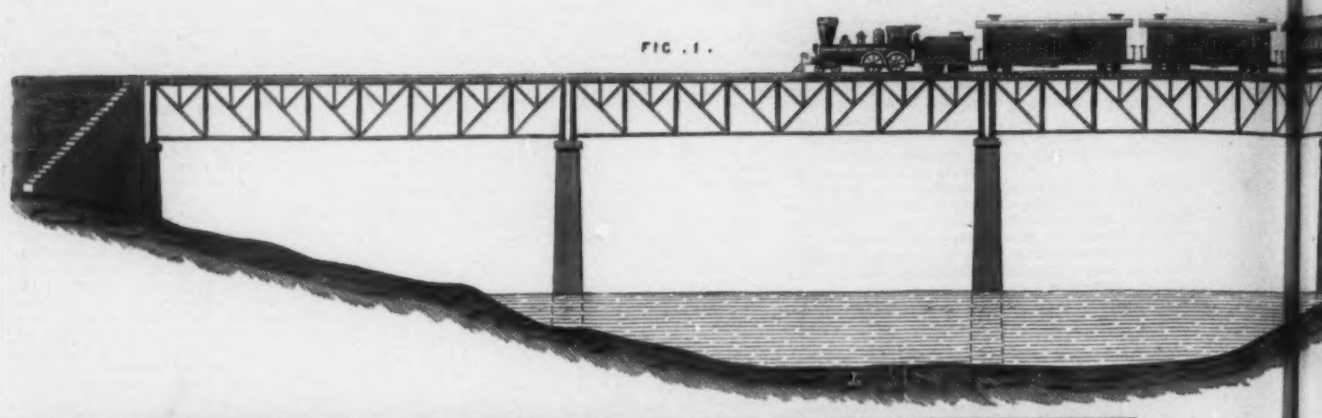


MOUNT UNION BRIDGE OVER THE JUNIA

JOSEPH M. WILSON AND

(*For Description,*

FIG. 1.



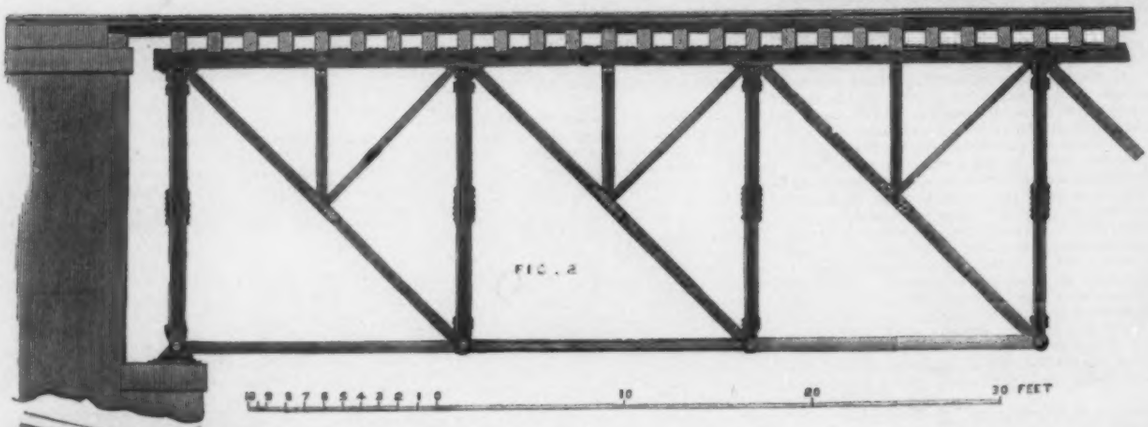


FIG. 2

FIG. 3.

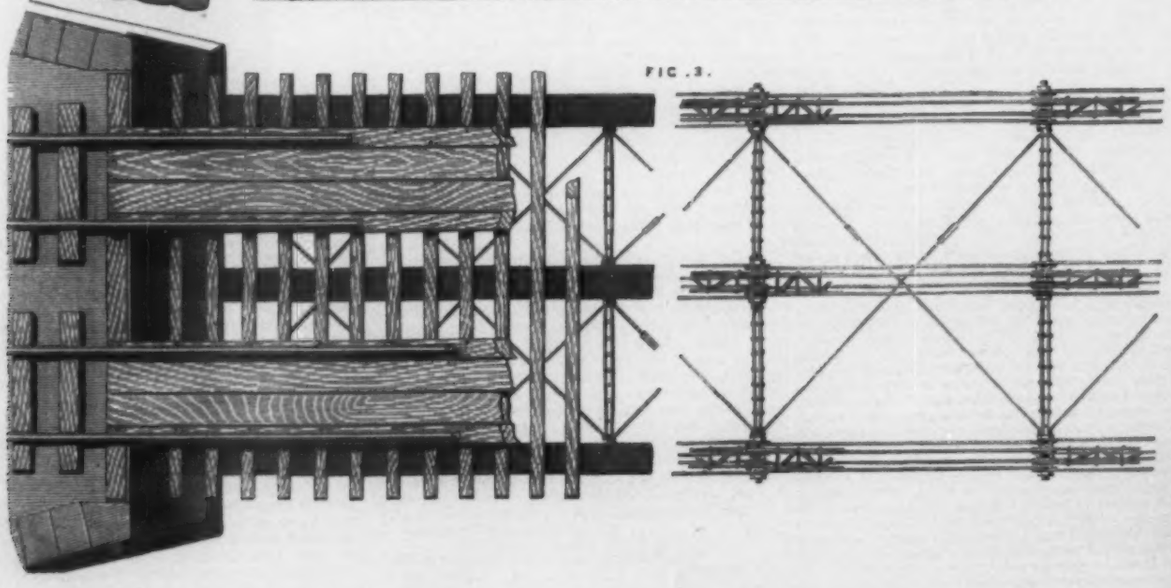
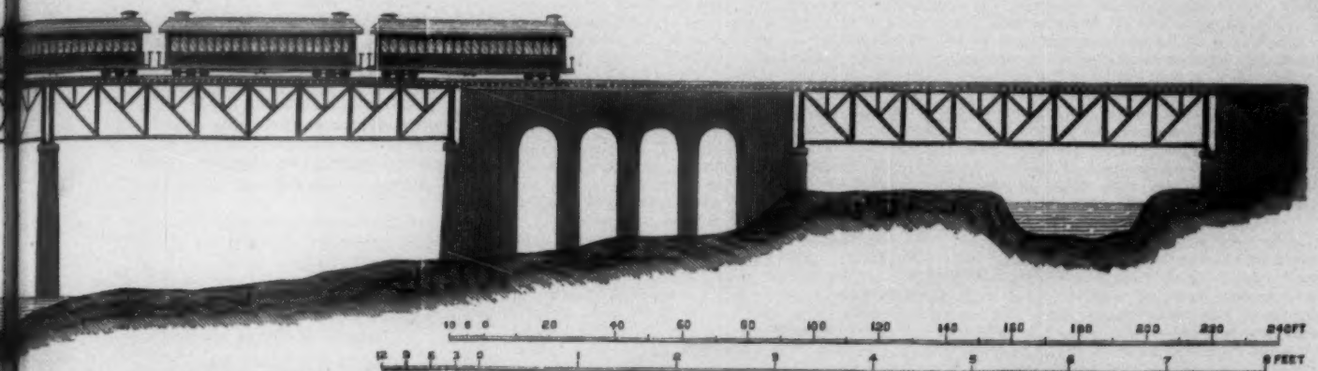


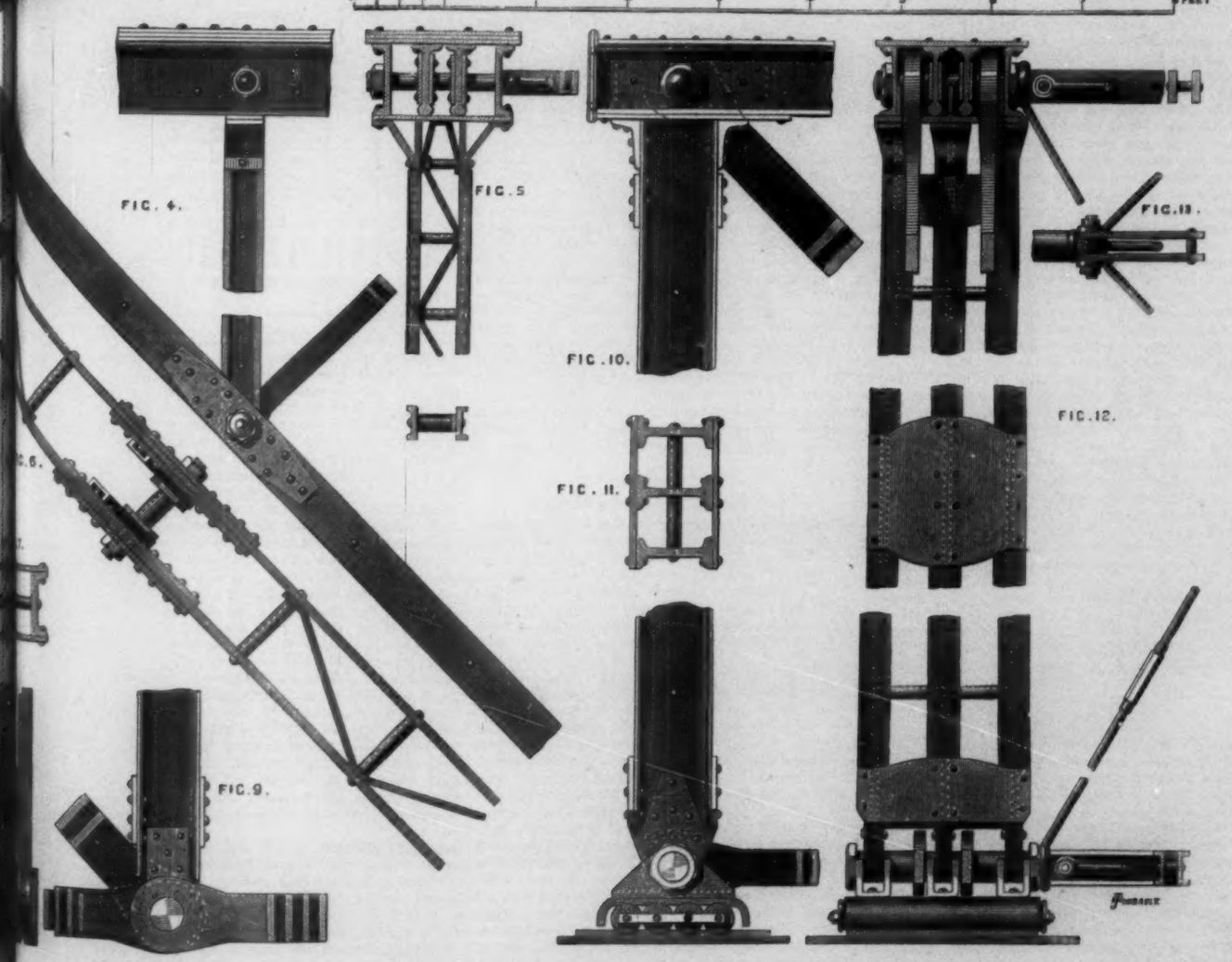
FIG. 4.

A RIVER; PENNSYLVANIA RAILROAD, U.S.

NRY PETTIT, ENGINEERS.

(ge 190.)





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CONTENTS.

	PAGE
Explosive Compounds	185
Nut-Tapping Machine	186
Jaskell's Floating Dock	186
The Berwick Water Supply	186
The North Sea Canal	186
Compound Marine Engines	187
The Rights of Inventors	187
Narrow Gauge Railways	187
Hot Gases	187
Centrifugal Dredging Machinery	188
Breech-loading Ordnance of the Middle Ages	189
Taking down a Chimney at the Tees Iron Works	189
The Harbour of Brindisi	189
Notes from Paris	189
The Mount Union Bridge	189
The Mont Cenis Tunnel	191
Nominal Horse Power	191
Traction Engines	191
The Ellesmere Company's Iron Works	192
The Mont Cenis Tunnel	193
Rent India—Progress and Condition	193
Notes from the South-West	195
Notes from the North	195
Notes from Cleveland and the Northern Counties	195
Foreign and Colonial Notes	196
Recent Patents	196
Another Ship Canal Project	196
Traction Engine Wheel	197
The University of Edinburgh	197
On the Use of Pulverised Fuel	199

ENGINEERING.

FRIDAY, SEPTEMBER 22, 1871.

THE MONT CENIS TUNNEL.

THE story of the skill, patience, and enterprise, the difficulties that were encountered, and the means developed for overcoming them in the slow and tedious construction of the Mont Cenis Tunnel, are now being so completely and so ably described in the long series of articles by Mr. Francis Kossuth, which are in course of publication in this journal, that in noticing the great engineering event of the week, little is left for us to do in this place, save to put on record the fact that the official inauguration of the tunnel took place on Sunday last, when Italian ministers passed through it from Bardonnèche to receive French congratulations at Modane. The modest celebration attending this event is in keeping with the quiet and unostentatious way in which the whole work has been prosecuted, its progress only being made known through many years past by occasional newspaper paragraphs or stray letters to the different journals.

Mr. Kossuth's articles form, in fact, the only complete account of the work from its inception to its completion. Far more stir, indeed, has been made about the temporary mountain road built upon Mr. Fell's system at so large an outlay; the duty of this line is now over, its rolling stock will before long be scattered, for the life of the line has been shortened by several years, owing to the energy with which the tunnel works have been pushed on to a conclusion.

It was on the last day of August, 1857, that Victor Emmanuel fired the first blast on the Italian side, and it was on last Christmas Day that the headings met under Mont Fréjus, and the tunnel could be looked upon as complete. More than 13 years of work had passed during the whole of which no show was made, save in the growing accumulation of débris, which marked the onward progress of the drifts into the darkness. Our readers are familiar with the method in which the tunnel was laid out, and how long a time was spent in the careful preparation of the preliminaries, the least error in which would have thrown the headings advancing on the opposite sides into wrong courses that would have diverged from each other with every yard of progress. The results proved the accuracy of all these early operations, when at last the work approached completion, and the drills of the Italian and French workmen could be heard at both headings, as the wall of rock decreased in thickness, dwindled to a shell, was broken through, and the centre lines of each portion were found to correspond.

But although the contract time for completing the tunnel was not approached by some seven years, if the energy which has marked the progress during the past few years had been steadily preserved from the commencement, the tunnel would have been opened almost at the same time as its companion marvel of modern European engineering—the Suez Canal. Political events, to some extent, interfered with steady advancement, and for the first five years the works were but slowly pushed forward. On the other hand, nothing but the ability and untiring energy of Sommeiller brought to perfection the mechanical appliances by which the piercing of the rock was effected, and by which the ultimate progress became so rapid.

It is somewhat difficult to realise the amount of mere mechanical work that had to be performed in excavating the passage under the Alps. The length of the tunnel is 13,364 yards, more than 7½ miles, and its sectional area is 71½ yards, so that about 960,000 cubic yards of rock had to be excavated and carried to spoil with an average lead of 1.875 miles. The weight of the mass of excavation could not have been less than 2,000,000 tons, representing a work of about 3¾ millions of ton-miles in the carriage to spoil. Mr. Kossuth stated in his article in this journal last week that the number of blasts required to excavate 130 cubic yards of hard rock was 400. If this proportion was uniform throughout the tunnel, there would have been 2,954,000 blasts required, consuming 580 tons of powder, to complete the work. And all this labour had to be performed under the most unfavourable conditions, in a confined space, which limited the number of men that could be employed, who had to work in an elevated temperature, without a ray of light, except from lamps, whose existence was dependant upon the supply of air forced in from the outside, while the whole of the machinery had to be driven from the same source that supplied the workmen.

From the commencement to the close, the works of the tunnel were carried on without error or failure, the genius of the lamented Sommeiller overcoming obstacles almost as fast as they arose; and the experience he has given to the world will ever secure for him his well-earned fame, for all that has been learned at Mont Fréjus will be put in practice elsewhere, as the necessities of commerce demand works from the engineer even greater than that which has just been so triumphantly concluded.

NOMINAL HORSE POWER.

THREE weeks ago in speaking of the portable engine trials to be carried out by the Royal Agricultural Society next year at Cardiff, we had occasion to express an opinion adverse to the rule by which it is intended that the "nominal" horse power at which the competitive engines are to be rated during those trials shall be calculated. Since then we have noticed in a contemporary some arguments urged in support of the new rule to which we have referred, and as we believe that these arguments are founded on a slight misapprehension of our statements, we desire to say a few words concerning them. In the first place, however, we may remark that we are glad to notice that our contemporary agrees with us in regretting that the term "nominal horse power" should be retained at all; and we, on our part, agree with our contemporary in considering that, in spite of its absurdity, the term will have to be retained for commercial purposes until the purchasing public is better acquainted with the capabilities of different engines. But we must differ from our contemporary when he urges that the new rule is an improvement upon those previously in use, and we do so in the first place because we regard the new rule as an unsuccessful attempt to give a definite value to an indefinite quantity; and in the second place because it lacks the facility of application which is the only thing which renders a rule of this kind excusable at all. The new rule, it may be remembered, is that the nominal power of the engines entered for trial shall be taken as "one-third the indicated power, at 60 lb. pressure in the boiler, cutting off at three-fourths the stroke, and the periphery of the fly-wheel running 1884 ft. per minute." We urged against this rule that it practically afforded to a maker the power of giving any desired "nominal" power to his engine—so long as the boiler power was sufficient—simply by varying the size of the fly-wheel, while our contemporary supports it on the ground that 1884 ft. per minute is a belt speed suitable for driving thrashing machines—and therefore an appropriate speed for the periphery of the fly-wheel of an agricultural engine—and also because the rule affords a relation between the nominal power of the engine and the power given out on the brake, which is quite independent of the size of the fly-wheel. The first of these arguments would be a perfectly legitimate one if, during the actual trials, the competitive engines had to be run at such a speed that the peripheries of their fly-wheels should move at 1884 ft. per minute; but no such limitation of speed is to be enforced, and hence we have the anomaly of there being no definite proportion between the speed at which the engines are to be actually run, and that at which their nominal power is to be estimated. This fact also disposes of the second argument urged in support of the rule.

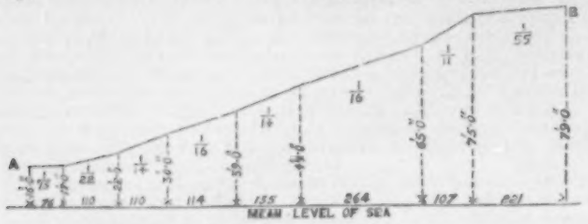
According to the terms of the prize sheet, the competitive engines are not to exceed 8 horse power, but we maintain that the rule for nominal power; as it at present stands, practically places no limit on the size of any engine which may be entered as an "8-horse" engine. For instance, all engines with fly wheels 5 ft. in diameter will have their "nominal" power estimated according to the indicated power they develop when running at 120 revolutions per minute, and all engines which indicate 24 horse power at that speed will be rated as 8 horse engines, quite irrespective of the speed at which their boiler power and general construction will enable them to work during the competitive trials on the brake. The opportunity is thus afforded to any maker who chooses to avail himself of it to enter an engine adapted for high speeds and with ample boiler power, and, having got it rated as an 8 horse engine by fitting it with a large fly-wheel, to then develop a power on the brake which would throw the performance of all the competitive engines of the same nominal power into the shade.

It is urged by our contemporary that high-speed engines are in no favour with the public, and that it "would probably be found a very bad speculation to enter on the construction of portable engines, with 3 ft. fly-wheels, intended to drive thrashing machines." This is undoubtedly to a great extent true; but it is also true that steam ploughing and traction engines are gradually paving the way for the introduction of high-piston speeds for general agricultural purposes, and there can be no doubt that the time is not very far distant when such speeds will be common. Moreover, as our contemporary justly observes, the Cardiff competition will be essentially a competition of "racers," and whatever may be the objections to the adoption of very high-piston speeds in general agricultural practice, they do not apply to such trials as those to be held by the Royal Agricultural Society next year. Taking all these matters into consideration, we cannot modify our opinion of the new rule for "nominal" horse power introduced by the Society, and we believe that when the Cardiff trials are concluded it will be found that the results will fully justify the opinion we hold, that the new rule will afford no definite measure of the real power of the engines entered for competition.

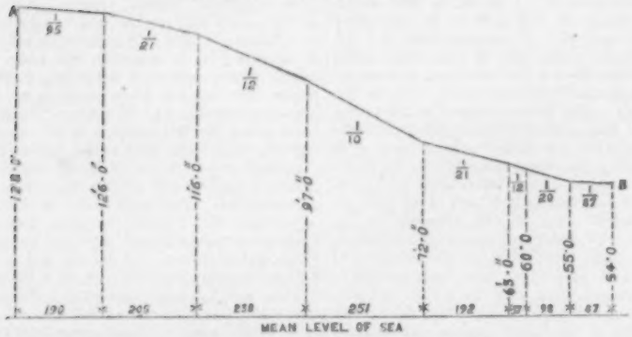
TRACTION ENGINES.

ON Tuesday last an interesting trial was made, on the road between Rochester and Chatham, of one of the light class of 6-horse traction engines constructed by Messrs. Aveling and Porter, of the former place. Engines of this class—to which reference has on several occasions been made in our pages—were first designed by Messrs. Aveling for the use of the Royal Engineers, and it was under the direction of a committee of that corps—by whom the name of "steam sappers" has been given to these engines—that the trial was made on Tuesday last. The principal gradients to be traversed had been accurately ascertained previous to the trial, and the latter was conducted under the immediate superintendence of Colonel Ray, R.E., Captain Clayton, R.E., the secretary, and other officers of the committee.

The engine with which the experiments were made was similar to that which did so good a duty during the recent trials of the Royal Agricultural Society at Barnhurst. It had a single cylinder 7½ in. in diameter, and 10 in. stroke, and driving wheels 5 ft. in diameter, while the gearing was in the ratio of 17 to 1. The boiler was of the usual locomotive type, with 25 square feet of firebox surface, and 84 square feet of tube surface, or 109 square feet of heating surface in all, while the firegrate area was 4.15 square feet. The weight in working order was 5 tons 4 cwt. 1 qr., of which weight probably about 4½ tons was, when the engine was pulling, thrown upon the driving wheels. The latter, we should state, were of wrought iron, the tyres having wrought-iron cross stripe rivetted on them diagonally.



SECTION OF STAR HILL, ROCHESTER.



SECTION OF BROMPTON HILL, CHATHAM.

The load consisted of four loaded wagons, weighing respectively 4 tons, 4 tons 10 cwt. 2 qr. 14 lb., 4 tons 8 cwt., and 2 tons 8 cwt., making together 15 tons 6 cwt. 2 qr. 14 lb., or, including the engine, 20 tons 10 cwt. 3 qr. 14 lb. This load was taken up the Star Hill, Rochester, in six minutes, the engine doing its work well, with scarcely any slipping, and the pressure of steam being 110 lb. From the section which we annex it will be seen that the total length of the Star Hill is 1137 ft., in which distance it rises 63 ft., giving an average gradient of almost exactly 1 in 18. The steepest part, however, is 1 in 11, and by far the greater portion of the length is on gradients of 1 in 14, and 1 in 16. The length of 1137 ft. accomplished in 6 minutes, gave a speed of 2.15 miles per hour.

After ascending Star Hill, a turn was made in the ordinary road with all the train coupled, this being exceedingly well done, and the course was then continued down a very steep and crooked hill by the Gibraltar Inn, and on through Chatham and over the drawbridge. At this point there was a very rough piece of paving with a sudden rise of 7 in. from the macadam on to the pitching forming the covering of the bridge, and at this point a tooth broke out of the compensating gear with which the engine is fitted. Here the train was taken over the bridge one-half at a time, and it was then coupled up again, and hauled up the steep and crooked hill near Chatham Church. It was very well done, although the road was freshly watered and very greasy. Next the train proceeded to the steep and winding hill leading past the Melville Hospital to Brompton, and here the last two wagons—weighing respectively 4 tons 8 cwt. and 2 tons 8 cwt.—were taken off, leaving the weight of the train, exclusive of engine, 8 tons 10 cwt. 2 qr. 14 lb. With this reduced load the engine went up capitally, and the train was then taken to the weigh-bridge in the Chatham Dockyard and weighed. The Brompton Hill is a very rough and hard piece of road, as all who are acquainted with Chatham well know. It is 1298 ft. in length, and rises in that distance 74 ft., the average gradient being thus 1 in 17.54. There is, however, a long piece of 1 in 10, and another of 1 in 12, as shown in the annexed section, and the hill is altogether one calculated to try a traction engine very severely.

Altogether the performance of Messrs. Aveling and Porter's engine on Tuesday last was an exceedingly creditable one, and the results attained fully bear out the opinion we have on previous occasions expressed concerning the adhesion to be obtained on macadamised roads by rigid wheels of proper construction. It may be remembered that when describing the competitive trial of the road steamer "Sutherland" with india-rubber tyres, and Messrs. Aveling and Porter's 10-horse engine at Tettenhall, near Wolverhampton, in July last, we expressed the opinion that if the latter engine had been fitted with wrought-iron tyres with cross ribs instead of the cast-iron tyres with which it was actually provided, it would have given a better performance.* The trial on Tuesday last, as we have said, bears out this opinion, and we probably cannot do better than give here a brief Table showing the performance of the road steamer "Sutherland" at Tettenhall, compared with that of the "steam sapper," of which we have just been speaking at the Star Hill, Rochester. The details of the two performances are as follows:

	Road steamer "Sutherland," with india-rubber tyres.	Messrs. Aveling and Porter's "Steam Sapper."
	tns. cwt. qr.	tns. cwt. qr.
Weight of engine	10 10 0	5 4 1
,, on driving wheels	7 11 1	
,, of train hauled	26 4 0	15 6 2½
,, ,, including engine ...	36 14 0	20 10 3¼
Weight of train hauled / Weight of engine = ...	2.5	2.94
Weight of train including engine / Weight of engine =	3.5	3.94
Weight of train hauled / Weight on driving wheels = ...	3.47	
Average gradients	1 in 20.3	1 in 19
Maximum	1 in 18	1 in 11
Speed in miles per hour	2.05	2.15

This comparison shows that, notwithstanding the much steeper gradient, and slightly higher speed, the rigid-wheeled engine took up a greater load in proportion to its weight than the road steamer, while the proportion between the load hauled, and that on the driving wheels, was probably almost exactly the same. These facts, we think, speak for themselves, and we think that they form the most complete reply which could be desired to the somewhat curious deductions—such, for instance, as those contained in Mr. R. W. Thomson's paper, lately read before the British Association—which have been made from the Tettenhall trials by some advocates of india-rubber tyres.

* *Vide* page 22 of the present volume.

THE LILLESHALL COMPANY'S IRON WORKS.

The works of this well-known Shropshire company, which were visited by us on the occasion of the recent meeting of the Iron and Steel Institute—consist of four establishments, viz., two sets of blast furnaces, situated at Prior's Lee and Old Lodge, respectively; a forge and rolling mills at Snigs' End, and engine shops at New Yard. We shall proceed to notice these works in the order in which we have mentioned them. A mineral railway line connects all these works together, and with the adjoining collieries; railways also connect them with the Great Western Railway on the south, the London and North-Western on the north, and the Shropshire Union Canals, at Lubstree Park, on the south-west. At the two smelting works there are together nine blast furnaces, eight of which are at work, making upon an average 1400 tons of iron—hot and cold blast—per week. At Prior's Lee there are four furnaces, making hot blast iron. These are 50 ft. in height. The ore, before it is put into the furnaces, is passed through a Blake's stone-breaking machine, driven by a small 25 horse power independent steam engine, and which will crush 30 tons of ore per hour; it is then raised by a vertical lift to the level of the furnaces. The furnaces are fitted with a Darby's bell to take the waste gases off to heat the steam boilers which feed the blowing engines. These are eight in number, seven only of which are heated by gas, and the remaining one by ordinary fuel; they are all double-flued boilers, 8 ft. in diameter by 30 ft. long, with flat ends. The engines consist of a pair of 60 horse power. All the slack coal is here washed in one of Edwards's coal-washing machines, and it is then coked for use in the blast furnaces. There are altogether 43 coking ovens at Prior's Lee, besides which a quantity of coke is made in mounds, all being employed in the blast furnaces. It is intended shortly to remodel the whole of the plant in this establishment, and to erect calcining kilns upon a larger scale than any in the district. At Old Lodge cold blast iron only is made, for which there are five furnaces employed. These were originally of the same height as those at Prior's Lee, but they have recently been raised by 20 ft., making them now 70 ft. in height, whereby considerable economy has been effected in fuel. These furnaces are kept in operation by a pair of Shropshire blowing engines, built upon the model of those which were shown in the International Exhibition in 1862. The steam cylinders are 40 in., and the blowing cylinders 86 in. in diameter, the engines having a stroke of 8½ ft. There are seven double-flued boilers 8 ft. in diameter and 27 ft. long, having flat ends, and ordinarily worked by the waste gases from the furnaces, but at present—owing to one of the furnaces having been blown out—stoked with fuel in the ordinary manner. Three calcining kilns, each 40 ft. in height, 26 ft. in diameter, and cased with iron plates, are used to prepare the ore, which is raised to the top by an incline plane, and by means of a small engine. Two pneumatic lifts are employed to raise the calcined ore and coke to the mouth of the blast furnaces. The slack coal is also here washed in an Edwards coal-washing machine, and coked in 86 ovens. The average make of iron at the company's furnaces is, as we have already stated, 1400 tons per week. The proprietors have, it is stated, a greater variety of ores at command than any other Shropshire firm; but their superior cold blast iron is made from an equal mixture of "blackstone," "hall-stone," "blue flats," and "pennystone." Of the former, each underground acre yields about 1500 tons; of the third, about 1600 tons; and the fourth, including the bottom pennystone, upwards of 3000 tons. In addition to these the company have the command of the "chance-pennystone," the "ragged-robins," the "brick-measure," the "yellow stone," and the "white flats," all of which are used, with about 20 per cent. of hematite and other ores in making hot-blast iron. The amount of coal and slack raised from the pits belonging to the Lilleshall Company amounts to about 432,000 tons per annum; the ironstone raised and purchased to 120,000 tons; and the débris in connexion with the latter to more than

700,000 tons. Of the winding engines employed at the pits, one is a 32 in. cylinder with 5 ft. stroke, non-condensing, and acting direct upon the drum-shaft. This engine is placed between two pits, raising, by means of flat wire ropes, the fungus coal from a depth of 306 yards on the one side, and the top coal from a depth of 339 yards on the other. A furnace, at the bottom, for ventilation, circulates about 35,000 cubic feet of air per second for both pits. The Grange pits were sunk in 1864. The pumping engine is placed directly over the water pit; it has a cylinder of 42 in. with a 9 ft. stroke, and two sets of pumps to raise the top water, the lower water being tubbed out at night. The Stafford pits are 240 yards to the randle and clod coals, and lie to the extreme east of the company's operations on the Shifnall side of their estates. The engines are each of 75 horse power, the one being employed in winding 200 tons of coal per day, whilst the other pumps 96,000 gallons of water in the 24 hours. The coal thus brought to surface is tilted upon an iron incline, sorted, and pitched into wagons waiting beneath to receive it. The Woodhouse colliery comes next in importance. Like the others above-mentioned, these shafts are 10 ft. in diameter, and worked with double bands of flat wire rope and two-decked cages, running on wood conductors, and raising 200 tons per day. In addition to the pumping engines already named, there is a 61-inch double acting condensing engine at Waxhills, pumping from a depth of 300 yards, one lifting and four forcing sets, varying from 11 to 13 in. in diameter; also a 52 in. beam engine, a 26 inch beam engine at Muxton Bridge, and seven water engines at Prior's Lee.

At Snigs' End are the forge and rolling mills situated in works spreading over an extensive area of ground. Here there are, in the whole, 40 puddling furnaces, situated in the two sheds. In the first shed are two mills, one rolling plates up to 12 in. in width, and the other for bars; there are also one helve of 3 tons, and one steam hammer of 2 tons 10 cwt. In the second shed are 3 wire mills, a merchant and a plate mill, the latter capable of rolling plates up to 12 ft. in length by 5 ft. 6 in. in width, besides a forge mill, helve, shears, and other necessary appliances required at such works. The largest shears will take a cut of 7 ft. 6 in. in length. The different machines in these works are driven by six engines, varying from 100 horse power down to 35 horse power.

The New Yard Engine Works are laid out upon a very extensive scale, and are fitted with every convenience. Through the spacious fitting and erecting shops a tram is laid for the convenience of transporting heavy castings and forgings from the foundry and smithy. At the entrance to the works are three coking ovens, which supply the cupolas with fuel. Next comes the boiler shop, where boiler and plate girder work is in progress; in it are a plate-bending machine, and two punching machines, driven by a small engine which, with its boiler, stands in one corner of the shop. Beyond this is a small gas house, with three retorts, communicating with a gasometer for lighting up the works. In the fitting shops there are between sixty and seventy machines in work, including lathes of various sizes, shaping machines, drills, planing machines, slotting machines, &c. The cylinder boring machine is capable of boring out a cylinder 18 ft. deep by 15 ft. in diameter. Amongst the various machinery in course of construction, we noticed a pair of large pumping engines for the Birmingham Water Works Company, with cylinders of 72 in. in diameter, and an 11 ft. stroke; a pair of winding engines for the Forest of Dean, besides machinery for Nettlefold and Chamberlain's new rolling mill, and Siemens's regenerative gas furnaces. In the smithy are 14 forges already erected, and there is room for nearly as many more, which can be put up as they may be required. There is also a steam hammer weighing 30 cwt. In the foundry are two cupolas and two air furnaces, and a 30-ton steam travelling crane. Castings can be made up to 40 tons in weight, although nothing so large has ever yet been cast there. We noticed here, also, a Scott's patent machine for moulding spur wheels, and which can be adjusted to mould wheels up to 16 ft. in diameter.

RAILWAYS IN NEW ZEALAND.—The provincial engineer of the province of Auckland, New Zealand, has received instructions to proceed with a survey of the Waikato Railway, making Mercer the terminus. The line is expected to prove of great benefit to the province.

THE MONT CENIS TUNNEL.*

ALLUSION was made in the last article to the elevated temperature, and to the vitiation of the air in the tunnel. These two causes excluded the possibility of the use of steam-worked machinery. Had this motor been used, it ought to have been produced on the spot, because steam cannot be transmitted to considerable distances without condensing, and as for the production of steam, fire is wanted, the surrounding temperature would have been insupportable, and would, further, through the absorption of oxygen, have made the air totally unfit for respiration.

Further, work is synonymous with heat produced, and hence the work itself, done by the machinery, would have contributed to render the temperature unbearable, had not the heat developed been counteracted by the motive power itself, which produced the work. For all these reasons it was self-evident that if mechanical means were to be used (and the work could not be accomplished without them), the motive power of the machinery employed was to be produced outside the tunnel, and carried along in the tunnel to the very spot where machinery was to be applied.

This problem had but one solution, which consisted in the application of compressed air as a motive power. This solution seems self-evident at first sight, because the application of compressed air as a motor is not a new idea nor a new invention.

Father Hall, a Hungarian Jesuit, in the middle of the eighteenth century, by means of a waterfall, guided compressed air in a tube to a recipient, from which this compressed air, passing in a second chamber, raised and discharged the water in the mines of Selmecz (Schemnitz).

Further, we remember that Montgolfier invented the hydraulic ram, by which he utilised the *vis viva* gained by water in its fall. But the application of these ideas to the production of mechanical work for the Mont Cenis tunnelling had to meet with many objections, and great difficulties. The difficulties not only consisted in the invention of compressing machinery capable of compressing the immense quantity of air wanted; they also arose from doubts on the possibility of constructing large hermetically closed recipients, such as would not allow the digression of the air.

Experiments had to be made on this subject, and a recipient was erected at Bardonnèche. It was filled with air compressed to six atmospheres, and was left 24 days untouched. Fortunately, only a very small loss was detected as having taken place, which did not even amount to $\frac{1}{2500}$th part of the daily production.†

It was objected that the transmission of compressed air to great distances, for the purpose of moving machinery, would hardly be possible, because of the loss of the pressure of the air produced by its friction along the conducting tube. This objection was considered a very serious one, as it was stated by great mathematicians, who made out apparently correct theories on the action of gases through long tubes. Further, several unsuccessful attempts had already been made to transmit compressed air, by Wilkenson and others.

It is true that Girard, and later, D'Aubuison and Marot, and again, the celebrated Poncelet and Peclet were more successful in their experiments; they were not sufficiently so, however, to decide absolutely the case in favour of the possibility of the undertaking.

By order of the Italian Government, experiments were made on this subject, and more especially on the hydropneumatic compressor proposed by Messrs. Sommeiller and Grattoni. The results of these experiments may be summed up in the annexed Table.

From this Table we see that for a length of 7108 yards, with tubes of $3\frac{1}{2}$ in. in diameter, supposing the original velocity per second to be 16 ft. $4\frac{1}{2}$ in., the loss of pressure at the end would only be $39\frac{1}{2}$ in., that is, about 1 and $\frac{1}{3}$rd of an atmosphere. Putting the initial velocity only at 13 ft. $1\frac{7}{10}$ in., the loss of pressure would be reduced to $27\frac{1}{2}$ in. or $\frac{1}{28}$ths of an atmosphere, and, if we suppose the tube to have 20 per cent. greater diameter, the loss would still be reduced by the half of this latter loss.

* In the formula on lines 15 and 25 of the third column of page 180 of our last number, "log." should be "hyp. log." The formula on line 30 of the same column also should read $t=a+t_1=273+t$, the signs t and t_1 in this formula standing respectively for the *absolute* temperature of the air and the temperature expressed in the ordinary way, these temperatures being taken in degrees of the centigrade scale. Also on line 10, from the bottom of the second column of page 180, "65.7 in." should be "65 ft. 7 in."

LOSS OF PRESSURE IN 1093.6 YDS. IN INCHES OF MERCURY.

			in.	in.	in.	in.	in.	in.
Diameter of the tubes			$8\frac{1}{2}$	$6\frac{1}{2}$	7	$9\frac{1}{2}$	$11\frac{1}{2}$	$13\frac{1}{2}$
	ft.	in.	—	—	—	—	—	—
Initial velocity per second.	3	$3\frac{1}{2}$ ...	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$
	6	$6\frac{1}{2}$ ...	$1\frac{1}{10}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$
	9	$10\frac{1}{2}$ ...	$2\frac{1}{10}$	$1\frac{1}{4}$	$1\frac{1}{10}$	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{3}{4}$
	13	$1\frac{7}{10}$ ...	$4\frac{1}{2}$	$2\frac{1}{2}$	$2\frac{1}{2}$	$1\frac{1}{4}$	$1\frac{1}{4}$	$1\frac{1}{4}$
	16	$4\frac{1}{2}$ ...	$6\frac{1}{2}$	$3\frac{1}{4}$	$3\frac{1}{10}$	$2\frac{1}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$
	19	$8\frac{1}{10}$ ...	$9\frac{1}{4}$	$4\frac{3}{4}$	$4\frac{1}{4}$	$3\frac{1}{4}$	$3\frac{1}{10}$	$2\frac{1}{4}$

The final results of the experiments alluded to above, are shown in the following Table:

Area of the orifice.	Velocity per second.		Gauge at the end of the tube.	Loss of Pressure.	
	In the tube.	When issuing.		Observed.	Deduced from the curve of interpolation.
sq. in.	ft. in.	ft. in.	in.	in.	in.
.0281	3 $3\frac{1}{2}$	439 10	$14\frac{1}{2}$	.1525	.1525
.0393	10 $5\frac{1}{2}$	473 0	$14\frac{1}{2}$	2.0472	1.7656
.0393	11 $5\frac{7}{10}$	501 11	$14\frac{1}{2}$	3.1969	3.125
.0393	11 $9\frac{1}{2}$	526 10	15	2.7187	2.35
.0393	13 $5\frac{7}{10}$	600 4	$14\frac{1}{2}$	2.3906	2.875
.1264	14 $5\frac{1}{2}$	495 1	$14\frac{1}{2}$	0.3677	3.844
.2776	32 $3\frac{1}{2}$	326 $2\frac{1}{2}$	$14\frac{1}{2}$	15.3906	15.2031
.4844	49 6	448 3	$14\frac{1}{2}$	35.5468	36.5468
.7639	60 $6\frac{1}{2}$	347 6	$14\frac{1}{2}$	61.4218	61.4218

The preliminary results observed at Bardonnèche confirmed those obtained by the experiments we have alluded to. In the Table given above we find that for a tube of $7\frac{1}{2}$ in. diameter, the air being compressed at 6 atmospheres, and the velocity being at the commencement $30\frac{1}{2}$ in. per second, the compressed air would lose for every 1093.6 yards, a part measured by a column of mercury of $\frac{1}{4}$th of an inch in height. Comparing this loss with the atmosphere, the loss would be represented by $\frac{1}{768}$, or $\frac{1}{1}\frac{1}{7}$th of an atmosphere for 1.24276 miles. Now when these tests were made at Bardonnèche the length of the tube conveying the compressed air was precisely this length. It had a diameter of $7\frac{1}{2}$ in.; the velocity of the air at the origin was 3 ft. $5\frac{1}{2}$ in. per second, and hence the the volume of compressed air flowing out at the opening was 1.109 cubic feet. Nine perforating machines working together consumed .9531 cubic feet every second, and the loss of pressure at the extremity of the tube was found a little inferior to $\frac{1}{1}\frac{1}{7}$th part of an atmosphere; and hence the result deduced from the Tables was confirmed by those practically obtained at Bardonnèche.

It may be interesting to give here a few theoretical observations on the movement of gas in tubes, nor will it be out of place, the subject being closely connected with the motive power which was used to carry out the perforation of the tunnel under the Alps. Besides, compressed air as a motive power, will no doubt receive very wide and important application in future, and hence mechanical and civil engineers cannot sufficiently study the questions which are connected with the important problem to the solution of which the possibility of the completion of the tunnel is owing. I shall, therefore, enter more fully upon this subject in my next article.

FRANCIS KOSSUTH, C.E.,
Royal Commissioner for Railways in Italy.

EAST INDIA—PROGRESS AND CONDITION.

(*Concluded from page* 161.)

WE next have to consider the progress of railway construction, and here, it must be understood, that the progress of state railways alone is referred to particulars concerning the guaranteed lines being contained in a separate report which is annually presented to Parliament. The first line of railway to which reference is made is the Khamgaon Branch Railway, connecting Khamgaon with the Great Indian Peninsula Railway at Jhelum, a distance of eight miles. This line was commenced on the 19th of June, 1869, and opened by the viceroy on the 4th of March following. Besides being important commercially, it is interesting as being the first state railway constructed by Government in India. The total estimate for its construction amounted to 54,089*l*. This line has already proved of the greatest

benefit, and from the date of its opening to the close of the season it had carried 40,000 bales, or nearly one-fourth of the cotton crop of Berar. When the line to Oomrawuttee, and another to the coal-fields of the Wurdah, are constructed, the requirements of the cotton trade will be fully met. In the Nizam's territory, surveys have been made for a state railway from Hyderabad to a place called Waddy, on the Great Indian Peninsula line, about 120 miles distant from Hyderabad. The entire line will be within His Highness's dominions; the British Government have undertaken its construction and its management and working hereafter; but the entire credit of this great project, which it is estimated will cost a million sterling, belongs to the Nizam's Government. In the Lower Provinces of Bengal no state lines have at present been undertaken, but in the Central Provinces a scheme for the construction of a light railway between Raepore and Nagpore has been prepared, and submitted to the supreme Government. In the Punjab, the sum of 36,392*l.* was laid out during the year upon state railways, viz., the Punjab Northern, from Lahore to Peshawur and the Indus Valley line, which is to connect Mooltan with Kurrachee. In British Burmah, a survey of the country has proved that there are no engineering difficulties in the way of the construction of the proposed railway between Rangoon and Prome, and very complete plans and estimates have been prepared.

But little is stated in the report now before us of the extension of telegraphs in India during the period under review. The most important work in this department was, however, the doubling of the line between Kurrachee and Bushire, by the submersion of a second cable between Jashk and Bushire, a distance of 500 miles, and by the extension of the Mekraw land line to Jashk from Guadur, a distance of 330 miles. The opening of the Indo-European Company's direct line from Teheran to London, *viâ* Russia, has very much improved the through working; but although the number of messages has very much increased, the receipts show an actual falling off owing to the proportion received for each message by this section being smaller than for messages, *viâ* Turkey. The competition has further improved the working of the Turkish lines. The opening of the Red Sea line was the third event which affected the Indo-European Telegraph Department in the year 1869-70. It is anticipated that with the increased traffic that will probably result from improved communication, the falling off in the receipts, owing to competition, will not be so serious as was at first apprehended.

The works next in importance to India, after communications, are canals and other works for carrying out a system of artificial irrigation. The wants of the country in this respect differ in various localities; for whilst some parts would almost become deserts if deprived of the present means of irrigation, others are, from the nature of their soils and from their geographical position, capable of doing without such aids to cultivation; thus, in a portion of Rajpootana the rain sinks into the sandy soil, and does not flow off the surface, so that a very small rainfall suffices for the crops. When the rainy season commences the sand-hills are ploughed up, and the seed planted very deep in the ground. The harvest in a good year much more than suffices for the wants of the population, but owing, unfortunately, to the want of storage accommodation, the surplus produce is wasted, being frequently left on the ground to be eaten by the cattle. In the event of the rains failing, however, all chances of a crop at all are lost. In Mysore 30,000*l.* was spent during the year on irrigation works, of which more than two-thirds were devoted to the repair of tanks, which are very numerous throughout that state. Attention has been drawn to the large sum of money spent annually on the repair of these tanks, and it is in contemplation that such works shall be carried out in future by the revenue officers instead of by the Public Works Department, and that the tanks, when complete, shall be handed over to the ryots for management and maintenance, subject to certain conditions. The agricultural works carried out by the irrigation branch of the Public Works Department are classified under the two heads of *extraordinary*, or works that are being executed out of loan funds, and *ordinary*, or those executed out of revenue, inclusive of repairs to existing works. In Bengal, Lower Provinces, those coming under the former head, are the Orissa and Behar Irrigation and Navigation Works, which were taken over by Government on the 1st January, 1869. At the time of their transfer very considerable progress had been made on the Orissa undertaking; but with regard to the Behar project little more had been carried out than the surveys and levels necessary for determining the site of the anicut across the Soane, and the alignment of the main canals. The original grant for carrying on these works was 430,000*l.*, but the actual expenditure fell short of it by 65,000*l.* The works falling under the head of ordinary consisted chiefly of embankments and sluices. The original grant for this class of works was 120,000*l.*, the revised grant amounted to 80,000*l.*, and the outlay came to 6000*l.* less. It appears that up to the end of 1869-70, the total outlay on the Orissa Canal and Irrigation Works had amounted to 1,100,000*l.*, that the income realised from them in the year under review was 5235*l.*, and that deducting this sum from the total charge for interest and maintenance, the net deficit was 53,862*l.* The total area irrigated by canals in the North-Western Provinces in 1869-70, was 24 per cent. less than the year before, owing to the seasonable rains of the latter half of the year under review, which made it unnecessary to have recourse to artificial irrigation; it denotes a loss of revenue to the Government, but a good season for the agriculturists. The falling off in the canal revenue was but 16 per cent., however; and the direct financial result, after deducting expenditure from the gross income of 324,198*l.*, was the net profit of 212,415*l.*, or 7.88 per cent. on the entire capital of 2,695,621*l.* No new canals have been completed since 1866-67, and the expansion of the benefits of irrigation is due, therefore, only to a fuller development of the existing works and to better management. Considerable progress was made in the construction of the Agra Canal, commenced in October, 1868, the expenditure during the year amounting to 50,000*l.*; and a scheme, the estimated cost of which is 820,000*l.*, for the irrigation of the districts of Bijnour, Moradabad, and Budaon, was submitted to the Government of India. The Ganges Canal waters the land situated between the Jumna and the Ganges. Commencing at Hurdwar, it flows south for 80 miles. East of Delhi it divides into three branches; the northern and main canal finally joins the Ganges again at Cawnpore, while the two lower branches are carried on to the Jumna. The waters of this canal are carried over 654 miles of main canals and 3112 miles of distributaries, the latter having been increased 72 miles in the course of the year. The canal paid a net profit of 7 per cent., the gross income of 256,896*l.* being an increase of 17,559*l.* over that of the previous year of unprecedented demand. The Eastern Jumna Canal is 130 miles in length, and has 606 miles of distributaries. Its revenue of 65,727*l.* was slightly greater than in 1868-69, giving a net profit of 25.7 per cent. on the capital expended. Oude is a part of the alluvial valley of the Ganges, and possesses no mountains. Its rivers, descending from the Himalayas, traverse the province in a parallel and south-easterly direction, affording abundant sources of irrigation, but there are at present no canals in existence in Oude. In the Central Provinces, although no "extraordinary" works of irrigation were commenced during the year, the subject continued to occupy the attention of the local authorities, and several schemes were completed and submitted to the Government of India. Experience has proved that the storage system is most suitable for the Central Provinces, where the ordinary flow of its rivers is unable to afford a sufficient and constant supply for the perennial irrigation of any large area, and where, owing to the deep channels of the principal streams, the head works would be so expensive that without a perennial and constant supply a fair return on the outlay could not be expected. The expense of storing water has been proved to be inversely in proportion to the extent of the reservoir. The lowest price for works constructed on this principle in England has been 3d. per cubic yard, but in India, where much larger areas are available, it has been as low as one-tenth of a penny per cubic yard. For the Central Provinces a system of tanks would be unsuitable, and would, moreover, prove too costly; to obtain a fair profit on the outlay, the works must be carried out on a grander scale, on rivers having large catchment basins. Of the seven projects [more or less complete, it will be sufficient to notice the project for storing a portion of the monsoon flow of the river Kanhan, and irrigating a large tract of country on its right or south-west bank, in the neighbourhood of the city of Nagpore. By throwing across the river at the village of Khappa, a masonry dam of 1870 ft. in length, and with an average height of 98 ft., a reservoir will be formed spreading water over more than 40 square miles of country and having a capacity of nearly 20 million cubic feet; from the reservoir will be conducted a main canal to Nagpore and onwards, and a minor canal for the irrigation of the lands north of Kamptee; the total length of the escape weirs will be 13,000 lineal feet; the plan includes two embankments of a total length of 5705 ft., and an average height of 45 ft. By this scheme the river flow, which unchecked cannot satisfy all demands upon it for more than 100 days, that is, during the rains, will be husbanded and prove amply sufficient for 221 days longer. It is expected, moreover, that a good trade will in a short time spring up along the main canal which is designed to facilitate navigation, and will be the means of transporting the produce of the country to the railway terminus at Nagpore. The entire cost of the undertaking, reservoir and distributary channels, is estimated at about 720,000*l.*, and this sum will provide a perennial supply of 1344 cubic feet per second at an average cost of 534*l.* per foot. Supposing the charge for the water to be at the rate of 6*s.* per acre per annum, the revenue it is estimated will be 11¼ per cent. on this outlay, when three-fifths of the gross area of 448,000 acres commanded by the distributary channels shall have been brought under irrigation. In the Madras Presidency there is the same complaint as in other provinces, of the progress of new irrigation works being retarded by delay in the submission of plans and estimates, owing to the time of the officers whose duty it is to prepare them being taken up with their current duties. The deepening of the tanks for the water supply of Madras made sufficient progress to allow of a large quantity of water being stored in them. The value of the work was at once proved by their enabling the fields to be fully cultivated, when without them the north-east monsoon having almost entirely failed there would have been no water. In the construction of Lake St. Lawrence, on the Neilgherries, has been attempted for the first time in the case of reservoir of large size what is termed the silting process by which the running water itself is made the agent for excavating and depositing the soil for the dam. Unfortunately, extraordinary floods broke through the embankment during the progress of the work, considerably retarding its completion. In Madura the project for diverting the waters of the river Peryaur from their natural outfall westward into the Vigay, which runs eastward into the Bay of Bengal, was vigorously proceeded with.

Coming now to municipal works, and taking the different provinces of India in the same order as before, it appears that in Berar the condition of the towns is being improved, and the municipal committees work well. In Mysore, many of the towns possess municipalities of which those of Bangalore, Mysore, Hassan, and Shimoga deserve special notice. In all four a good system of drainage either has been or is being carried out; the roads and streets are maintained in capital repair, and many useful improvements have been accomplished. In Lower Bengal, an Act was passed for the completion of the Calcutta Water Supply Works, by which the justices of the peace are empowered to levy a water rate on the town. The Calcutta Municipal Act, by which the municipality was established in that city, came into operation on the 1st July, 1863. The income of the municipality in 1869 was 280,722*l.*, and the expenditure 252,213*l.* The two great works in hand are those for the water supply and the drainage of Calcutta. The first was sufficiently advanced at the close of 1869 to admit of a regular supply of water to the town; and with regard to the latter, 138,714 ft., or 26¼ miles, of the new system of sewers have been constructed and are in use. In the North-Western Provinces, municipal Government is becoming year by year more firmly established, and on the 31st March, 1870, no less than 63 towns throughout the province were subject to the Municipal Act of 1868. Their statistics of income and expenditure show that the committees are exercising an important influence in drawing forth local resources and in supplying local requirements. Much the same remarks are also applicable to Oude, where there are 12 towns in which the Municipal Act is in force, and the movement is said to be extending. In the Punjab, 118 towns have municipal committees. Of Madras, it is stated that it is evident the feeling in favour of

municipalities is strengthening, and that the inhabitants begin to appreciate the benefits of improved conservancy and consequent freedom from epidemics, as well as the facilities to traffic afforded by the roads being now kept in good order.

In conclusion a few remarks may be here in place with regard to the industries of India. From important discoveries made during the past year, it appears most probable that the mineral resources of the Hyderabad Assigned Districts are immense. The total area of the coal-fields which lie on both sides of the Wurdah exceeds 1000 square miles, of which 560 square miles had been carefully surveyed, and some very valuable beds of iron ore in the neighbourhood have recently been brought to light. The steamers plying on the Upper Indus are supplied with coal from six mines in the neighbourhood of Kalabagh, in the Punjab, which produced good fuel, but as a rule the mineral resembling coal, found in various parts of the Punjab, has proved on examination to be lignite, more or less charged with iron pyrites and sulphur, and is not in sufficient quantity to be of much commercial value. The province possesses sandstone, granite, and other kinds of stone useful for building purposes in abundance, also marbles, limestone, and gypsum, extensive slate quarries, and petroleum. The only mines of importance in British Burmah are the tin mines of Mergui, which would be very remunerative if properly worked; as yet none but Chinese have entered the field.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Since last report there has been some fluctuation in the prices of pig iron in the local market, advancing from 60s. 5d. cash and 60s. 8d. one month, the prices paid on Wednesday last to 61s. 6d. cash and 61s. 10½d. one month, which were the top prices on Monday at the opening of the market. Lower prices were afterwards taken, and yesterday at the close the prices stood at 60s. 10½d. cash and 61s. 2d. one month for buyers; sellers, 1d. to ½d. more. The market to-day has been steady, business done at 60s. 10½d. to 60s. 9d. cash and 61s. 1d. to 61s. 2d. one month. The shipments during the past week were unusually good for this time of the year, being: Foreign, 14,807 tons; coastwise, 6658 tons; total, 21,465 tons. Same week last year, 10,651 tons; increase for week, 10,814 tons. Total shipments for 1871, 567,585 tons; 1870, 443,841 tons; increase for the year, 143,744 tons. The imports of Middlesbrough pig iron into Grangemouth for week ending September 16, 1871, were 2166 tons; same week last year, 1835 tons; increase for week, 330 tons. Total imports to date 1871, 59,014 tons; for same period last year, 47,429 tons; increase of imports for 1871, 11,585 tons. Large quantities of Coltness, Gartsherrie, Summerlee, and Shotts iron are being sent to the United States; and the local founders are using No. 1 Carron iron to a large extent in admixture with Middlesbrough No. 3. There is little or no reduction being made in the stocks in public stores, but makers' stocks are diminishing rapidly, and their prices remain very firm.

The Malleable Iron Trade.—There is no further appearance of any difficulty arising on the question of wages in the finished iron trade of Lanarkshire. Prices remain firm and the demands are very large, especially for ship plates, boiler plates, and angle iron. All the mills are kept constantly engaged.

Extensive New Works for the Manufacture of Iron and Steel.—A very wealthy private company has been formed in Glasgow for the manufacture of finished iron and steel. I understand that the company will make steel on the Siemens-Martin process. They have secured about 100 acres for the erection of works at Newton, five or six miles to the east of Glasgow, and intend to go into the business on a very extensive scale. The company will consist chiefly, if not exclusively, of a number of the principal shareholders of the Tharsis Sulphur and Copper Company.

Advance of Wages in the Mining Districts.—Throughout most of the mining districts of Scotland, more especially in the west country, there is a general advance of colliers' wages—in Ayrshire, Renfrewshire, and in the Maryhill, Motherwell, and Larkhall districts of Lanarkshire. The Fifeshire miners have solicited an advance of one shilling per day, but it does not seem as if the full extent of their demands will be acceded to. Most of the employers in Fifeshire have signified their willingness to grant an advance. It is stated that after the rise in the Motherwell district the wages will be 5s. 6d. per day.

Short Time Movement amongst Glasgow Engineers.—A movement is on foot amongst the journeymen engineers in the Clyde district for the purpose of abolishing the system of overtime. It is said that a number of the men are desirous of an agitation for a greater allowance for overtime, should the practice of working over hours be insisted upon by the employers. Complaints of a similar sort are also being made amongst the engineers of Edinburgh and Leith.

A New Mineral Field at Bathgate.—Mr. Thomas Wilson, mineral borer, Armadale, who has been for some time past employed on the estate of Inch, the property of Mr. John Waddell, the well-known contractor, on Wednesday last came on another seam of the famous Houstoun coal. The seam is 4 ft. 6 in. thick, and as it is of excellent quality, means for working it will speedily be adopted.

Short Time Movement amongst the Caledonian Railway Servants.—Referring to the movement for a short time system among the Caledonian Railway employés, a local paper says:—Although it is generally admitted that the hours of labour are, in many instances, somewhat long, still many of the oldest drivers on the line cannot see how the present system of running the mineral traffic can be remedied, and as the result of the present agitation they only anticipate an advance of wages to some branches of the service, and the introduction of eight hours' "shifts" to the pointsmen employed at some of the principal junctions. Nothing definite is known as yet regarding the feeling of the authorities. The absence of Mr. Britton, the locomotive superintendent, from Glasgow, has caused some delay, and the presentation of the proposed petition from the men through that gentleman to the directors of the Caledonian Railway will not take place until Friday next, the 22nd inst.

Engineer's Report on the Tay Bridge Works.—The following report, by Mr. Thomas Bouch, C.E., will be submitted to the forthcoming meeting of the North British Railway Company: "I have to report that the contract for the erection of the Tay Bridge, entered into with the Messrs. Charles De Bergue and Co., was signed on the 8th of May last. The contractors lost no time in making a commencement, but experienced some difficulty in obtaining possession of land on which they desired to build a pier and caisson platform, &c., so that it was nearly the end of May before they started with the temporary works which, for such a great undertaking, are extensive and costly, and necessarily required preliminary to commencing the permanent structure. There is now erected of timber a pier, 230 ft. long by 20 ft. broad, for landing materials at, a timber platform, of 1000 yards area, alongside of which the caissons are to be erected preparatory to their being taken to their respective positions in the bridge. One air-bell for the caissons is finished and ready for use, the other is to be ready in three weeks. A crane, adapted for the erection of the caissons, and hydraulic machinery, with girders for pontoons for lowering the cylinders, are brought to the works. Two new barges, small steamer, and two small boats are at the works. Two large pontoons for carrying heavy caissons are to be at the works by the end of this month. Besides forty-five tons of general plant, such as rivetting tools, &c., there are delivered at the works one jib and three travelling cranes, eight Hayley's jacks, seventeen forges, and eight crabs. Of the permanent structure, the land abutment on the Fife side is built up to within 4 ft. of its height. The first land pier is up to its height of brickwork ready for the girder-bearing blocks of ashlar. The second land pier is built up to the height of 8 ft. above high-water level, and the excavations for foundation of the third pier are at present being taken out. Of temporary buildings there are erected three large stores for cement, iron, &c., a smithy, offices, a building for the accommodation of a large number of workmen, and a steam hoist that is at present required for taking the materials landed at the pier up to level of ground. Of permanent materials there are two hundred and fifty tons of cast-iron plates for caissons finished, of which seventy-seven tons are delivered; of wrought-iron bases, twenty-four are made, of which six are delivered, and eighteen are on the way to the works; of malleable iron bolts, five tons; of cement, one hundred and twenty tons; of bricks, eighty thousand are delivered at the works; iron for the girders of the 36 ft. spans, and the bedplates for the 60 and 80 ft. spans are being prepared."

Discovery of Hematite Iron Ore in Caithness.—At a recent bazaar in Thurso, some fine specimens of iron ore were exhibited. The ore was found on the estate of Sir Robert Sinclair, Bart., and has been pronounced by Professor Anderson of Glasgow to contain first-class hematite iron. While certifying to the quality of the iron and to the large percentage the ore contained, Professor Anderson expressed doubts as to the ore being found in sufficient quantity to make it a profitable speculation. Recent investigation proves the existence of a large deposit, and a sanguine expectation prevails that more will be found to be embedded at a greater depth. Should this expectation be verified, it is the intention of Sir Robert to work the mineral.

NOTES FROM THE SOUTH-WEST.

Trade at Swansea.—At the last South Wales and West of England coal and metal market at Swansea, the reports made as to the condition of the staple trades of the district were satisfactory and indicated advancing prices in good pig iron and iron ore. There were many inquiries for hematite pig, although most consumers are well bought. Mr. Groves exhibited some samples of Norwegian red hematite ore and also of spathose ores. The latter were expectionally fine, but it did not transpire from what locality they came, and their price was not quoted. A large lot of Acklam refined metal was reported sold at 4*l.* per ton.

The Sewage Question in Wales.—On Wednesday, in last week, some gentlemen from Birmingham visited Troedyrhiw for the purpose of inspecting some filtering areas designed by Mr. Bailey Denton for the Merthyr Board of Health. The deputation was accompanied by the chairman of the Board and Mr. Sutherland. The visitors were conducted over the works by Mr. Harpar, surveyor to the Local Board; and also by Mr. Hutchinson, who has had the carrying out of Mr. Denton's designs. The members of the deputation expressed their pleasure and satisfaction with what they witnessed.

Advance in the Price of Coal.—The proprietors of the Somerset and Dean Forest collieries have made an advance in the price of coal. The advance is 6d. to 1s. per ton.

Taff Vale Railway.—The traffic of the Taff Vale Railway has not yet fully recovered from the effects of the great labour disputes in the district through which its line runs. In the ten weeks ending September 9 the aggregate receipts were 40,270*l.*, as compared with 60,847*l.* in the corresponding period of 1870.

Trade at Newport.—At the last South Wales and West of England coal and metal market at Newport, some considerable sales in tin at better prices were reported. There was an increased tightness of prices for hematite pig, and 85s. per ton was asked for No. 3 brands. Tin-plate makers were busy and were not disposed to enter fresh orders until the next meeting of the tin-plate trade, which will take place early in October.

Bristol United Gas Light Company.—The half-yearly meeting of this company was held on Thursday in last week, the chairman (Mr. W. Naish) presiding. Mr. Naish referred to the works of the company, and said the new retorts in St. Philip's were capable of producing a very great quantity of gas; but owing to the delay experienced in obtaining a sufficient amount of gasholder accommodation to store it, the company was not able at present to avail itself fully of its new means of production. The dividend declared at the meeting was at the rate of 10 per cent. per annum.

Pensford Railway Viaduct.—The chief engineer has condemned some of the piers of the Pensford viaduct on the North Somerset Railway, on the ground that they are too slight for the weight which they will have to bear. They are consequently to be pulled down and stronger ones are to be built. This will, of course, involve a delay and entail also a considerable extra expense upon the company.

Nantyglo and Blaina Iron Works.—A report has obtained currency to the effect that the 100,000*l.* recently raised by an issue of 8 per cent. preference shares will not be sufficient to place the works of the Nantyglo and Blaina Iron Works Company (Limited) in an efficient state. Time will test the accuracy of the rumour.

Welsh Shipping Movements.—The Belle Morse has cleared from Newport for San Francisco with 1751 tons of iron supplied by the Ebbw Vale Company. The St. Olaf has cleared from Cardiff for Galveston with 410 tons of railway iron supplied by the Aberdare Iron Company. The Royal Charter has cleared from Cardiff for New York with 1663 tons of railway iron supplied by the Dowlais Iron Company. The Pactolus has cleared from Newport for San Francisco with 1456 tons of iron supplied by the Ebbw Vale Company. The Victoria has cleared from Cardiff for Mobile Bay with 1000 tons of railway iron supplied by Messrs. Guest and Company. The Wild Hunter has cleared from Newport for New Orleans with 1000 tons of iron supplied by the Blaenavon Iron Company. The L'Allegro has cleared from Cardiff for Talcahuano with 900 tons of railway iron supplied by the Rhymney Iron Company. The Fanny has cleared from Cardiff for Montreal with 553 tons of railway iron supplied by Mr. R. Crawshay.

Somerset and Dorset Railway.—It is expected that the works in connexion with the extension of the Somerset and Dorset Railway from Evercreech to the Midland at Bath will be commenced in March.

The Forest of Dean.—The coal trade of this district is troubled by a strike, but trade is brisk at the collieries not on strike. Other branches of local industry continue active.

Monmouthshire Railway.—The traffic on this line presents a satisfactory increase. In the ten weeks ending September 9, the amount of revenue collected was 34,055*l.*, as compared with 31,229*l.* collected in the corresponding ten weeks of 1870.

Trade at Briton Ferry.—A large vessel has arrived to load rails for the Briton Ferry Iron Works. Large quantities of Spanish and other iron ore continue to arrive, and a considerable increase in the number of steamers using the port is observable. The introduction of the narrow gauge is expected to prove highly beneficial to the commercial interests of the district.

The Midland at Bath.—The Midland Railway Company is about to proceed with the erection of new bonded stores near its Bath station. The tender of Mr. Robinson, of Bristol, has been accepted for the execution of the works, which will involve an outlay of about 5000*l.*

Labour and Capital in Wales.—The steam coal colliers in the Cardiff district have not yet quite settled down, although the output of coal is increasing. There are also threats of another great strike in Wales. Altogether, the relations of labour and capital in the Principality can scarcely be regarded as satisfactory.

Trade at Merthyr Tydvil.—Trade about Merthyr Tydvil is considered to have been rather less active of late. The business doing in bars and rails is still, however, satisfactory.

Rhymney Railway.—The prospects of this line are considered to be improving, now that it has completed a connexion with the London and North-Western. The amount of revenue collected to September 9, this year, was 12,817*l.*, as compared with 11,011*l.* in the corresponding period of 1870.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Market.—Yesterday there was again a numerous attendance on 'Change at Middlesbrough. For pig iron of every quality there was a good demand and the market closed firm at last week's quotations. Makers are doing their utmost to keep the deliveries equal to the pressing demand. Shipments are active.

The Finished Iron Trade.—There is really nothing new to report in connexion with the finished iron trade. All the departments are busy.

Strike of Ironworkers at Middlesbrough.—All the ironmasters and ironworkers with one or two exceptions in the North of England are members of the Board of Arbitration which has for its object the settlement of trade disputes in an amicable manner. One of the main objects of the Board

is to arrange differences without work being stopped instead of employers and employed fighting by locks-out or strikes. Unfortunately since the establishment of the Board the men on several occasions have violated the chief regulation, and have on a difference arising left work at once. Yesterday a case of this kind occurred at Middlesbrough. The puddlers at the Britannia Iron Works—a splendid establishment which was noticed at some length recently in ENGINEERING—complained of the quality of the iron they had to work. They wished better iron, or in the event of not obtaining that a higher price for working the same quality they had been puddling. The manager told them that he could not supply them with iron of a superior quality, and instead of continuing at work and submitting the question to the Board of Arbitration which consists of representatives of employers and employed they struck. To-day they are still on strike. They have had a meeting and have decided to ask the operative secretary on the Board of Arbitration (Mr. John Kane) to come and inquire into the matter. Mr. Kane is to visit Middlesbrough to-morrow (Thursday), and it is very probable that he will point out to the men that they have made a mistake in leaving work. They will probably decide to return to their furnaces and submit the matter to the Board of Arbitration.

The Nine Hours' Movement.—So long has the unfortunate strike in the engineering trade at Newcastle for the adoption of the nine hours' movement lasted that it has become a question of the greatest importance, and is being discussed in all quarters. During the past week little new has taken place. A few more foreigners have been imported by the masters, and a large number have left the factories and returned to the Continent. The masters contrive to keep their factories open, but the dissatisfaction amongst the foreigners who live at several of the works is very considerable. The number of strike hands in Newcastle has been reduced, owing to men obtaining work elsewhere, to 1986. This week the League have paid these men 8s. each. Meetings in favour of the men are being held constantly throughout the kingdom. All the trades unions are taking the question up and are subscribing to the nine hours' movement. The men are very confident that they will yet obtain the nine hours.

More Railway Facilities for Middlesbrough.—At the Middlesbrough Chamber of Commerce yesterday the desirability of improving the railway communication between the Hartlepool coal-field and the Cleveland district was again discussed. During the present year it will be remembered that a scheme having this object in view was rejected by a committee of the House of Commons, owing to a swing bridge across the Tees at Middlesbrough forming part of it. Yesterday a committee of the Chamber of Commerce was appointed, and they will collect such information on the subject as will enable the people of Tees-side to take the question up in a way that will insure success.

FOREIGN AND COLONIAL NOTES.

Railways in Tasmania.—Mr. Wylie, an engineer sent out by the Tasmanian Main Line Railway Company, has been making a flying survey of the line, and taking levels of the country. The Mersey and Deloraine Railway will soon be partially opened for traffic.

Australian Mechanical Industry.—Messrs J. and A. Rodgers, of the Newcastle foundry, New South Wales, have recently contracted for three large 40 ft. engine turn-tables upon a plan designed by the colonial railway engineer-in-chief. At present Messrs. Rodgers are employing about forty men and boys; and in addition to their turn-table contract, they are effecting extensive repairs to the Government dredger Vulcan and the tug Boaribang which have been undergoing a thorough overhaul of their hull and machinery. They have also sundry other bridge and general ironwork on hand.

Russian Steam Navigation.—The Russian Steam Navigation Company's steamer Thighatcheff, has returned from Shanghai, after a continued outward and home voyage through the Suez Canal of a little more than five months. She brings a cargo of 66,000 lb. of tea; of the value of 1,000,000 roubles.

Northern Pacific Railway.—The directors of the Northern Pacific Railway have accepted from the contractor the road from Duluth westward to Crow Wing on the Mississippi river, a distance of about 120 miles. Track laying is being rapidly pushed forward, and in a short time the road will be in running order across the entire length of Minnesota.

The Ural.—The average level of the water in the Ural river has, it is stated, fallen 1 ft. 2½ in. within the last ten years. The delta was formerly much wider than at present, the river having 19 branches at its entrance into the Caspian. Now, however, 14 of these are filled up and the Ural empties into the Caspian by only five mouths.

Intercolonial Railway.—The commissioners for the execution of the Intercolonial Railway are pushing on the section from the terminal station of the Grand Trunk Railway of Canada at Rivière du Loup to within a mile of Trois Pistoles River—a distance of 23 miles. Beyond this point the track cannot be laid owing to the bridge across the river—an extensive work—not being completed. A locomotive recently made a trial trip over a bridge across the Du Loup; the bridge sustained the strain with a deflection of only ½ in. on the whole length which is about 300 ft. This bridge is a wooden structure, but nearly all the other bridges on the line will be of iron.

Prince Edward Island.—An ocean steam ship company has been formed in Prince Edward Island for the purpose of trading by steamer direct to Liverpool. An order has been despatched to Glasgow for the building forthwith of a first class iron steamer to be ready to take in cargo in March, 1872.

RECENT PATENTS.

THE following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

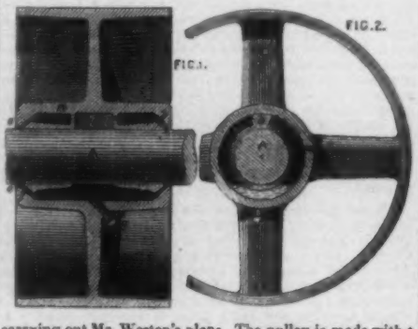
(No. 2658, 10d.) John William Fletcher, of Chester, patents a neat little portable apparatus for facilitating the soldering the joints of telegraph wires. The apparatus consists of a small trough for containing the melted solder, this trough being partly surrounded by a perforated casing between which and the trough itself is placed the fuel for heating the solder. The fuel used consists of a mixture of sixteen parts of wood charcoal and six parts of nitrate of potash, these materials being finely ground, mixed with sufficient mucilage and moulded into cakes about ½ in. thick, and cross lined so that they can be readily broken up into cubes for use. It is stated that the apparatus enables soldering bits and fire pots to be disposed with, and there are, no doubt, numerous circumstances under which its use would be very convenient.

(No. 2668, 1s. 10d.) William Edward Newton, of 66, Chancery-lane, patents, as the agent of Robert Spencer, of New York, apparatus for disintegrating and de-sulphurising ores which we could not describe briefly.

(No. 2678, 1s. 4d.) William Robert Lake, of Southampton-buildings, patents, as the agent of John Houpt, of Springtown, U.S., some complicated arrangements of condensers, &c., for steam engines, which it would be impossible for us to describe briefly. The plans included in this patent are stated to be improvements in those patented by Mr. Houpt, in April, 1870.

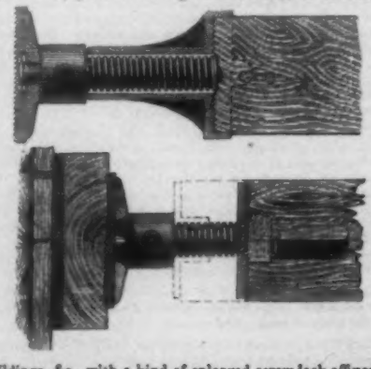
(No. 2684, 10d.) James Shand, of 75, Upper Ground-street, Blackfriars, patents an arrangement for assisting engines over the dead centres without using a fly-wheel. According to this plan, the valve spindle is fitted with a piston working in a small auxiliary cylinder, the arrangement being such, that when the main crank is on a dead centre the pressure of steam on the valve spindle piston acting through the valve rod, on a crank from which the valve derives its motion, tends to turn the crank shaft in the proper direction, and thus enables the dead point to be passed. The valve rod thus alternately impels and is impelled by the crank shaft. We shall very probably illustrate these plans shortly.

(No. 2704, 8d.) David McColley Weston, of Boston, U.S., patents fitting pulleys, &c., with self-lubricating bosses. The annexed sketch will explain one mode of



carrying out Mr. Weston's plans. The pulley is made with a hollow boss into which oil can be introduced through the hole closed by the plug, *g*. At each revolution of the pulley, the scoop, *b*, takes up a certain quantity of oil and delivers it on the uncovered portion of the shaft. Any oil working out at the ends of the boss is caught by the grooves, *c*, and returned by the action of centrifugal force, through the passages, *f*, to the oil reservoir.

(No. 2709, 8d.) Giardinelli Spooner Kirkman, of Battersea Rise, patents making timber struts or shores for



buildings, &c., with a kind of enlarged screw jack affixed to one end so that the length of the struts, &c., may be readily adjusted. This arrangement, two forms of which we show in the annexed sketch, is likely to prove useful in many instances.

ANOTHER SHIP CANAL PROJECT.

AN old engineering scheme has been resuscitated, one for which Parliamentary powers were sought as far back as the year 1841; it is that of cutting through the peninsula of Kintyre, in Argyleshire, for the purpose of establishing chiefly a new and easy route between the Firth of Clyde and the West Highlands by means of a ship canal. Why the project was then abandoned we are not aware, but we believe there are good reasons for resuscitating it, notwithstanding that there is the well-known Crinan Canal running through the isthmus from Ardrishaig. By means of the projected ship canal it is intended to join East and West Tarbert, the line of the canal being about 40 miles from the extremity of the peninsula, the point which is known as the Mull of Kintyre, and the canal itself being about 1¼ miles in length. In the opinion of competent engineers there are no great practical difficulties to interfere with the ultimate realisation of the scheme, and yet the amount of money required for it—140,000*l.*—does seem a pretty large sum for cutting 1¼ miles of a canal. The probable expense of the undertaking was estimated in the year 1841 at 120,000*l.*, but it is difficult to see how, even with the rise of wages during the last thirty years, 20,000*l.* more should now be required, if we bear in mind the great increase of engineering skill, and the varied engineering appliances that have been brought into use during the same period. It has been suggested that two lines of steamers should have their calling places respectively at East and West Tarbert, and that the passengers and other traffic should be conveyed across the isthmus by means of a tramway. This might possibly do if the promoters of the scheme simply anticipated ordinary passenger and tourist and the accompanying traffic, but we can conceive of such a canal being extensively useful for Atlantic and the West of Ireland lines of steamers trading to and from the Clyde, and we doubt not that the promoters of the Tarbert Canal scheme anticipate such a traffic. There is no doubt that rounding the Mull of Kintyre is one of the most dangerous bits of navigation around the coasts of Britain, and it seems morally certain that the owners of sea-going vessels would much prefer such a canal as is projected to risking the dangers of the south end of Kintyre, On the West Highland traffic there would be a saving of well nigh two hundred miles, and if that be expressed in money, there would be a large item to start with towards making a proper estimate of the probable return on the money invested in the construction of the canal. It has been estimated that the interests of somewhere about 200,000 people would be affected by the facilities which the Tarbert canal would offer for ready and safe intercourse with Glasgow and Greenock, and other places upon the Clyde. Industries, which to the West Highlands are strangers, would doubtless spring up, owing to the readiness with which coal and other materials could be conveyed to suitable places, owing to the cheapness of the labour that could be obtained, and owing, likewise, to the facilities for getting access to large markets with the industrial products. Wisely, we think, have the landed proprietors throughout the district of Kintyre acted in pledging themselves to assist by their means in carrying out any well-considered scheme for accomplishing such objects as we have referred to. To the tourist such a scheme must be of great interest, as the scenery opened up is unsurpassed in Scotland for rugged and picturesque beauty.

THE GAUGE QUESTION IN CANADA.—The extent of railway with a 5 ft. 6 in. gauge in Canada is computed at 2345 miles; that with a 4 ft. 8½ in. gauge, at 593 miles; and that with a 3 ft. 6 in. gauge, at 104 miles. It must not be inferred that all this extent of line is set quite in actual operation. The Intercolonial Railway is being constructed on the same gauge as the Grand Trunk, viz., 5 ft. 6 in.

FLOODS IN INDIA.—There have been very alarming floods in the Punjab and in Guzerat. Railway bridges over the Jumna, beyond Saharunpore and over the Beas beyond Jullundur have become impassable, and passenger and goods traffic has been stopped between Saharunpore and the Beas river. The valuable bridge across the Beas was, indeed, broken down and a train was precipitated into the gulf beneath. About 180 yards of the Punjab Railway on the Jullundur side of the river was also carried away by the flood. Happily there does not appear to have been any lives lost by the falling of the doomed train into the Beas; when the disaster happened almost every one had left the carriages.

WATER SUPPLY FOR WEST CALDER.—Owing, in great measure to the location of the famous works of Young's Paraffine Light and Mineral Oil Company, at Addiewell, West Calder, the population of the village has increased with the past decade from about 500 to 3400, and for a considerable time there have been complaints of great scarcity of water. These have now been removed by the construction and completion of new water works, the opening of which took place last week. The works were designed and superintended by Mr. John Buchanan, C.E., Edinburgh. The source is in a spring about three miles distant, and the supply is equal to about 25 gallons per head for a population of 3000 people. As the spring rises at a height of nearly 120 ft. above the level of the village, there will be ample pressure in the event of a fire. The works have been executed at a cost of 1600*l.* The ceremony of turning on the first supply was performed by Miss Young, daughter of Mr. James Young, the founder of the mineral oil industry.

TRACTION ENGINE WHEEL.

CONSTRUCTED BY MESSRS. CLAYTON AND SHUTTLEWORTH, ENGINEERS, LINCOLN.

FIG.1.

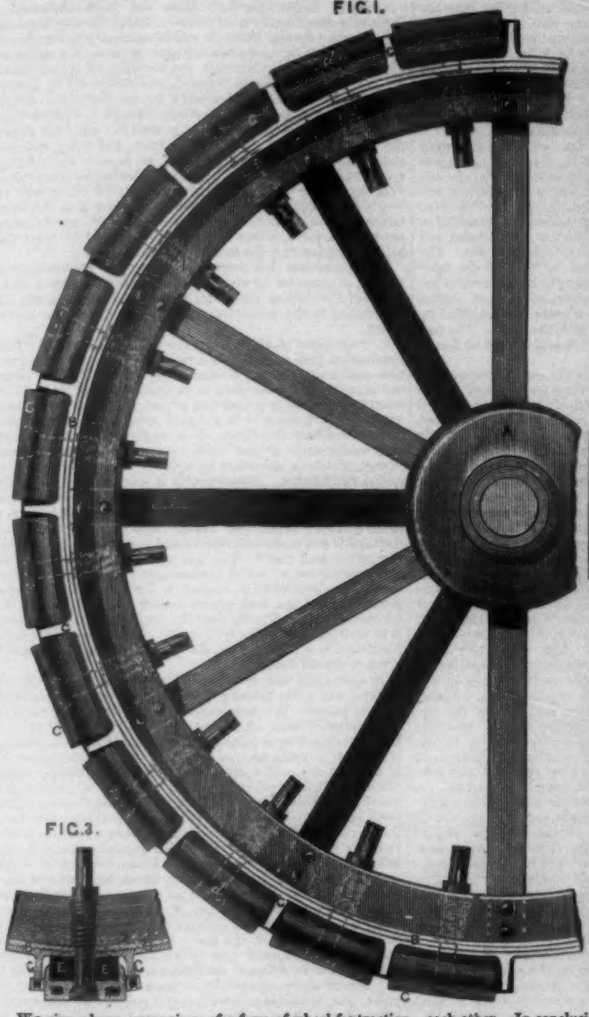


FIG.2.

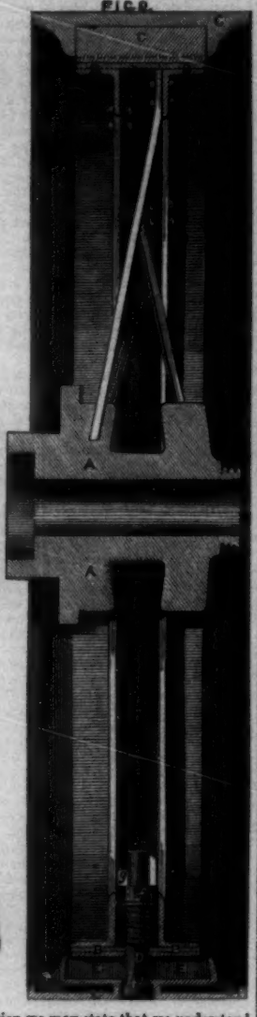


FIG.3.

WE give, above, engravings of a form of wheel for traction engines designed and recently patented by Messrs. Clayton and Shuttleworth, of Lincoln. In this wheel the tread is constructed of a number of separate and independent "transomes" or "transverse sole or bearing plates" having their upper and lower surfaces parallel, these transomes being placed transversely across the rim of the wheel, and being connected with it at suitable intervals—so as not to be in contact with each other—by means of a central bolt, having a hemispherical head which fits into a corresponding socket in the transome. The bolt just mentioned then passes through the tyre of the wheel, and is held in position by a cottar bearing upon concave and convex washers. By this means a ball and socket or universal joint is formed which enables each transome to roll or adjust itself to any requisite angle upon the tyre or rim and thus accommodate itself to the irregularities in the surface of the road, much in the same way that the ancle joint acts in the human foot. The surface of the tyre or rim of the wheel is rounded so as to form a segment of a sphere in order to facilitate this play or adjustment, and a cushion of india-rubber or other suitable elastic material is interposed between each transome and the tyre or rim of the wheel to permit a more perfect play.

In our engravings A is the nave of the wheel, and B a wrought-iron rim to which are connected at convenient intervals the several transomes or bearing plates, C C, placed transversely across the rim. This connexion between the rim and the transomes is effected by means of the bolts, D D, formed with hemispherical heads, *d*, which fit into correspondingly shaped cups or sockets formed in the centres of the several transomes. Between each transome and the rim of the wheel there is interposed a block or cushion of vulcanised india-rubber, E E. The transome and its cushion, E, are held close up to the rim by means of a spiral spring, F, surrounding the bolt, D, which spring bears at one end against the inner surface of the rim, and at its opposite end against a loose collar, *f*, which is slipped on to the bolt and secured in place by means of a cottar, *g*. A series of transverse raised ribs or projections, G, formed on or attached to the rim or tyre serve to separate the several transomes from each other. In conclusion we may state that we understand that Messrs. Clayton and Shuttleworth are now subjecting the wheel to a practical test, and we trust in due time to be able to give particulars of the results.

THE UNIVERSITY OF EDINBURGH.

THE fact that the recent meeting of the British Association was held within the walls of the University of Edinburgh, coupled with the fact that the mechanical science section was presided over by the Baxter Professor of Engineering, naturally directed attention to the chair established through the munificence of Sir David Baxter, Bart., of Kilmaron. That chair may be said to be, in a measure, one of the fruits of the agitation which arose out of the Paris Exhibition of 1867, an event which was the cause of a great many valuable letters being written by scientific men urging the importance of efforts being made to provide a thorough system of technical education for the rising generation, and for skilled artisans generally. Sir David Baxter, an eminent Forfarshire manufacturer and merchant, taking a deep interest in the educational facilities afforded by the University of Edinburgh, was induced to give a sum of 5000*l.* to endow a chair of engineering and mechanical science in that university, providing that the Government of the day would also give some material aid for the maintenance of such a chair. There was no good reason why Edinburgh should not be on a similar footing with Glasgow, London, Manchester, and other places in respect of engineering education; and the Government, acting on the principle of helping those who help themselves, ultimately agreed to supplement Sir David Baxter's munificent endowment by an annual grant of 200*l.* The salary of a professor being thus tolerably well provided for, the next thing was to secure the services of a gentleman who could perform the duties of his office in such a way as to show that the new chair was one of the necessities of the times. Mr. Fleeming Jenkin, F.R.S., who had already earned his laurels as a professor, as well as in telegraphic engineering, and as an original investigator, was elected to the Baxter Professorship, and the work of the class was commenced forthwith. The class has now become one of the recognised features of the University of Edinburgh, it has got into thorough working order, and we are, therefore, now in a position to consider its condition and its future prospects.

The number of students in the regular engineering class during last winter session—from November to April inclusive—was 32, which was a very sensible increase upon the number enrolled in the preceding session. It is chiefly from mechanical or civil engineers in embryo that the class is made up. Some of the best of the students are assistants in engineering offices, a few are amateurs, and there are likewise some who have been workmen, who are rising in the world a little. Of course, all such intending students as are not fairly well prepared are discouraged by the professor from joining the class. In addition to the regular class just referred to there is a class for mechanical drawing, which is open four hours daily during the session. This is as nearly as may be the representation of an engineering office. Drawings are lent by engineers in the town, especially Messrs. Hawthorn, of Leith, and Messrs. Blyth and Cunningham, C.E., Edinburgh, and by the students they are traced, or copied, or coloured, as professional exercises. There is also a surveying class, the duties of which embrace a fortnight's lectures in summer, together with a fortnight's work in the field. The students of this class remain all day in the field, and are accustomed to the use of the theodolite, the level, the sextant, the prismatic compass, and all ordinary surveying instruments. They work in batches of four, each batch having its own instruments. During last session the number of students in the surveying class was twelve, and in the mechanical drawing class eleven; but in both cases the members of these extra classes are matriculated students of the engineering class proper.

The course of instruction for this general class extends over two years, or rather two winter sessions, each of them embracing, as a rule, about 100 lectures; but the subjects of study are so arranged that students may begin their engineering studies in either session with equal advantage. The following is something like an outline of the subjects which may be said to form the first year's course:

(1.) Principles of statics; couples, moments of forces, parallel and inclined forces, centre of gravity, moment of inertia, &c.

(2.) Equilibrium and stability of frames, bracing, cords, ribs, and linear arches.

(3.) Strength of materials; stretching, crushing, bending, creaking, and twisting.

(4.) Strength of the simpler forms in which materials are used; screws, studs, bolts, rivets, shafts, belts, toothed wheels, brackets, bearings, cranks, ropes, chains, wires, &c.

(5.) Application of mechanical principles to combined structures, especially roofs and bridges.

(6.) Construction of roads, railways, and tramways.

(7.) Principles of dynamics; Newton's laws of motion; conservation and transformation of energy.

(8.) Application of the principles of dynamics to prime movers, especially locomotives.

(9.) Manufacture of telegraph cables, apparatus, &c., or some other manufacture.

The other year's course of study embraces the following subjects:

(1.) Statics, as in the first year's course.

(2.) Application of statics to the determination of frictional stability.

(3.) Hydrostatics.

(4.) Construction of water works and drainage works.

(5.) Harbours.

(6.) Application of kinematics to machinery, illustrated by millwright work.

(7.) Dynamics, as in first year's course.

(8.) Steam and the condensing steam engine.

(9.) Water wheels and turbines.

(10.) Manufactures.

Since the Baxter Professorship was instituted, engineering students have been declared eligible for the degrees in science conferred by the University of Edinburgh. For the degree of bachelor of science two examinations are held, the first embracing mathematics, natural philosophy, and chemistry; and the second, mathematics applied to mechanics, engineering, and drawing. In order that an engineering student may proceed to the degree of doctor of science, he must prove that he has passed under a civil engineer in practice. He must then be examined in Practical Engineering, choosing (1) the design of machinery, with complete drawings, specifications, and estimates; or (2) the preparation of designs, specifications, and estimates for civil engineering work; and under the head of Applied Science he may choose any one of the following five subjects: applied mathematics, chemistry, geology, one branch of natural philosophy, or telegraphy.

The university authorities recommend a certain course of study for engineering students to pursue, especially with a view to take a science degree in the engineering. It is a three years' course, and is as follows:

1st Year. Mathematics, geology, geometrical drawing. In this year there is time for the students to take the English, Latin, logic, or any other general culture class.

2nd Year. Mathematics, natural philosophy, engineering, mechanical drawing.

3rd Year. Surveying and levelling, natural philosophy, engineering, chemistry.

It will thus be seen that a most complete course of instruction is provided in the University of Edinburgh for such persons as aim at entering the engineering profession, either in the mechanical or the civil branch; and the arrangements whereby engineering students may secure a university degree are of the most liberal character.

Of course, it can scarcely be expected that all the arrangements connected with the Baxter Professorship are such as would be deemed desirable, considering that it has only been so recently instituted. The holder of the chair receives as remuneration for services rendered, the interest of 4000*l.* of the Baxter endowment, supplemented by 200*l.* per annum from the Treasury, and the students class fees. For a gentleman of the professional eminence of Professor Jenkin something more would seem to be desirable, if not even necessary, in the way of remuneration. At present he teaches mechanical drawing as a sort of hobby, but if he is to attend to his professional duties, as he ought, it is clear that he cannot devote much time to such teaching, and it seems to us that a qualified assistant at, say, 100*l.* a year, is a *sine qua non*. Then, again, in order that the engineering class may be made thoroughly efficient we should think a proper class room one of the first necessaries. It is not right that any one room in the university which confers such distinction on the Scottish metropolis should be jointly held by three professors. When such is the case and the three professors lecture in it in succession, how is it possible that they can do the full measure of justice to their respective classes, even in the way of showing proper models, diagrams, &c.? The university buildings are apparently very extensive, but they certainly are not sufficiently complete for the many and varied causes of instruction required in our present advanced stage of civilisation; and it surely cannot long be the case that the professorial instruction in one of the most civilising departments of learning shall be conducted under such difficulties as Professor Jenkin has now to contend with.

The subject of electric telegraphy and telegraphic engineering has never yet attained that prominence in any one of our educational systems that its importance demands; but considering the special professional qualifications and antecedents of the Baxter Professor we believe that the authorities of the University of Edinburgh and the Government would do well to consider the propriety of instituting a distinct course of lectures and practical demonstrations on that subject. We doubt not that Professor Jenkin would gladly undertake the necessary duties. But, of course, considerable funds would be needed in order to accomplish the work properly. For the instruments at starting something like 1000*l.* would be required, besides some 200*l.* or 300*l.* annually for new instruments and laboratory expenses; while a sum of 400*l.* or 500*l.* per annum would also be required for the salaries of the professor and his assistant. Still, it is not an impossibility to establish a thorough school of telegraphy in connexion with the Baxter Chair of Engineering; and we need scarcely say that we ardently hope that an effort to establish such a new educational feature for our profession will be made forthwith.

ON THE USE OF PULVERISED FUEL.*

By Lieutenant C. E. Dutton, U.S. Ordnance Corps.

Having been invited by Messrs. Whelpley and Storer, of Boston, to visit their establishment, and examine their new method of applying fuel to metallurgical and other purposes, I have been so profoundly impressed with the results of the experiments witnessed, that I take the liberty to lay before the society a discussion of the subject. Their method consists in pulverising the coal to an extreme degree of fineness, and blowing it into the combustion chamber, where it is ignited and burned in the air which floats it.

The generic idea involved in this process is not new, for it has, during the last forty years, been made the subject of numerous patents in England,† and possibly elsewhere. But to most practical minds it will certainly appear to be new, and will at first receive the hasty judgment passed upon new ideas. Yet nothing can be more certain than that the principles upon which are based the claims of superior economy and efficiency in this mode of utilising fuel, are entirely sound, and are demonstrable by well-known laws of thermodynamics, and by practical considerations familiar to every educated engineer. Although known to some of the highest class of engineers, and considered by them as "theoretically sound," yet it has received particular attention in but few cases, owing to the want of practical means of carrying it into effect. The invention of Messrs. Whelpley and Storer has overcome this practical difficulty in a manner so surprising and complete that it seems well worthy of being ranked in importance and value with the discoveries of Bessemer and Siemens. The defect which has hitherto rendered this valuable idea a practical nullity has been the want of a contrivance for pulverising coal with uniformity and cheapness. It needs but a moment's reflection to be satisfied that crushing by stamps, or by rolls, and grinding with stones, would cost far more than the best results we could hope to gain—let alone the difficulty of transvecting the dust from the pulveriser to the furnace—a matter no less important than pulverising itself. Let us see how the invention in question annihilates these difficulties.

Conceive an ordinary blowing fan with the following modifications. The box is about 18 in. diameter, and about the same length. Instead of opening at both ends, one end is tight around the journal. The box is divided into two chambers by a diaphragm, so that, really, we have two fans on the same shaft, and their boxes communicate by a hole in the diaphragm around the shaft. The fan at the closed end of the box is, in form and function, a blowing fan. The outer fan is the pulveriser. The coal is fed into the open end of the pulverising chamber, is caught by the swiftly revolving paddles, and reduced to powder, and is then sucked by the fan through the diaphragm, whence it is expelled by the ordinary tangential pipe along with the blast. The coal is fed in the form of coarse gravel; it is delivered as fine as flour.

The mere statement of the facts in the case at first appears singular. Had any person, who never saw or heard of this contrivance before, been asked to give his opinion as to what could be the result of feeding coal into such an apparatus, he surely would not have predicted the results actually obtained. It would have been quite natural to expect a little splintering of the coal, and the speedy clogging of the pulverising chamber, or perhaps the destruction of the whole machine in its efforts to clear itself of its contents. But as the truth is quite otherwise, we may well ask by what kind of action is the coal reduced to powder? It is not ground, for the machine is expressly constructed to avoid a grinding action, the paddles being in no case nearer to the walls of the cylindrical shell than ¾ in.; nor does the coal seem to be comminuted altogether by splintering against the iron surfaces, for although such action undoubtedly takes place at first impact, yet when it has reached a certain stage, and that by no means near the ultimate one, it cannot seemingly continue to any material extent. The only explanation occurring here, and that not at all satisfactory, is that in the powerful commotion produced by the swift rotation of the paddles, the particles clash fiercely together and triturate each other—a view confirmed in some measure by the appearance of the dust under the microscope. But whatever the mode, it is certain that the coal is pulverised to an extreme degree. I have watched this machine for hours, and have caused it to be fed under my own eye, and the products collected in a bag, of which I submit a sample. As nearly as I can estimate by microscopic measurement fully nineteen-twentieths of the particles are less than $\frac{1}{250}$ in. in diameter, and none exceed $\frac{1}{125}$ in. From the open end of the pipe it floats away in a dense cloud of smoke, and, singularly enough, not a black smoke, but of a reddish brown colour, differing strikingly from the jet black of coal. This may, or may not, indicate extreme minuteness of subdivision; I offer no explanation of it. The still more astonishing performance of this machine in reducing quartz, ores, grain, &c., will be alluded to hereafter.

The function performed by this machine is a double one. It pulverises the fuel and delivers it, along with the blast, into the combustion chamber, by a single and indivisible operation. This combination of two acts into one is of vital importance, and may be said to constitute the central idea of the mechanical part of the process. It would otherwise be useless for metallurgical or even for calorific purposes. It removes at a single coup the two most formidable obstacles which have hitherto rendered the use of pulverised fuel impracticable. Another feature of high importance is the mechanism for regulating the supply of air and coal. The inventors have devised an excellent apparatus for this purpose, which controls both with precision; but as this is merely a matter of mechanical detail, I presume it will be taken on trust, and a description of it is omitted. I shall confine myself to a description of the functions performed by it, which are greater than would at first appear. The pulveriser seems to be governed by very definite laws, and a precise practice in the amount of work it can perform with economy. A machine, working upon a given fuel, will have its efficiency modified by three variable conditions:

1st. The velocity of the shaft.
2nd. The quantity of coal introduced.
3rd. The quantity of air introduced.

1. With regard to the first condition, practice has shown that there is a uniform, or nearly uniform, velocity suitable to every machine, which may be set down at about 10,000 ft. per minute for a point on the periphery of the paddle, which, for an 18-inch pulveriser, would be about 2100 or 2200 revolutions per minute. If the speed be diminished, then the coal will be less thoroughly pulverised and will burn imperfectly and wastefully in the furnaces. If the speed be increased, the fineness of the dust will also be increased, but the power required to attain a higher velocity increases in a very large ratio, and the increased fineness of the product is not sufficiently advantageous to compensate the cost of increased speed.

2. The feed of fuel will of course be determined primarily by the requirements of the furnace, and the minimum quantity which will effect the desired temperature will, in each case, be determined experimentally. If the fuel be diminished, an insufficient heat will be obtained, and if it be increased, the loss will be threefold: (1) the surplus fuel will burn to waste; (2) the effort of the machine to clear itself from an overwhelming supply will absorb more power; and (3) drive out the coal before it is sufficiently pulverised—in brief, the result being, more power and more fuel consumed and less heat developed.

3. The amount of air admitted should be sufficient to float readily the pulverulent coal, but no more. If excessive the increased draught through the pulverising chamber will float out much larger particles than can burn sufficiently. Generally speaking, it is advisable to keep the supply of air quite small. In any event it will be necessary to supply air for combustion by a separate air-pipe, because, if a sufficient quantity were passed through the machine, it would carry out the fuel insufficiently reduced, and moreover, in special applications it becomes necessary to use hot-blast, which would necessarily enter the furnace through a separate pipe—the air from the pulveriser being always cold. Air enters the pulveriser through the same inlet, and along with the coal. The aperture is adjustable, as is also the feeding apparatus, thus affording perfect and instantaneous control over the supply of both. The advantage of being able to stop a fire completely in an instant, and renew it in full force as quickly, and also to regulate it at pleasure, by the mere motion of a valve, or hand lever, is so great as to need the merest mention in order to be appreciated.

The pulveriser has been applied by its inventors to a variety of purposes, of which I shall discuss two, which seem to afford the widest range for possible advantages, viz., its application to the reverberatory furnace, and to the steam boiler.

1. *Pulverised fuel in the reverberatory furnace.*—This application does not involve a radical change in the structure and design of the furnace; the chief alteration being the omission of the fireplace in its present form. Instead of constituting a large proportion of the entire structure, and of prime importance, it is reduced greatly in size, and performs subsidiary functions. It is employed, at first, to raise the temperature of the walls to redness around the coal tuyere, which is necessary in order to ignite the dust as it enters the furnace. Subsequently it is kept closed as tightly as possible, and the fuel within it serves merely to deoxidise the air, which filters through the doors, and to supply a small quantity of carbonic oxide. This small supply of inflammable gas materially assists and insures the speedy ignition of the coal dust.* The gas generator is supplied with anthracite culm, of which it consumes only about 30 lb. per hour. The pulveriser is located a few feet behind the gas generator, and the coal tuyere enters the back wall of the furnace, pointing directly over the fire bridge. The air tuyere is located just above the coal tuyere. The furnace, therefore, is reduced to a hearth, with the pulverising machine in the stead of the old fireplace.

In discussing the comparative theoretical merits of this method, and grate burning, some preliminary considerations may be proper. It is necessary to be mindful of the fact that the amount of heat, that is to say, the number of units of heat, developed by the complete oxidation of a given quantity of fuel, of a particular constitution, is a constant quantity. It matters not under what circumstances oxidation takes place, whether explosively, as in the case of commingled gases, or by that slow combustion which sometimes requires years to accomplish, the gross amount is always the same. But we are dealing chiefly with temperatures in the reverberatory furnace—a matter in which quantity of heat is only one of several equally essential conditions, any one of which may be so varied as to occasion the widest variations in temperature. Thus, the increment of temperature produced in a body of gas by the accession of a given quantity of heat, will vary inversely as the volume of that gas—also inversely as the specific heat of the gas. Hence it appears that if we increase the volume of gas (or solid ether), through which the heat is to be diffused, we diminish the temperature; or if we impart given quantities of heat to given volumes of gases, the temperatures will vary inversely as the specific heats of the gases. These facts are familiar enough to every student of thermodynamics, and are mentioned merely for the sake of continuity in the argument.

(*To be continued.*)

Wear and Tear of Rails.—The Melbourne and Hobson's Bay Railway was laid in the first instance with rails weighing 55 lb. per yard. The weight of the engines used upon the line was under 25 tons, but the rails failed in less than three years. The line was relaid about 14 years since with rails weighing 75 lb. per yard, and these were in good order a year since. The St. Kilda branch of the Melbourne and Hobson's Bay Railway was laid in the first instance with rails weighing 55 lb. to the yard, and placed in longitudinal sleepers; in less than two years these rails had to be taken up, and the line was relaid with rails weighing 75 lb. and 80 lb. a yard. These were a year since in good condition.

Railways in New South Wales.—The New South Wales Government recently carried a resolution in the Legislative Assembly of that colony (by 17 to 4) affirming the desirability of borrowing 1,000,000*l.* sterling for extensions of the existing lines of New South Wales to Yass, Orange and Tamworth. The resolution was carried in committee of the whole house, the committee was counted out before progress was reported, and the matter consequently lapsed. The colonial railway engineer-in-chief estimates that the cost of the proposed line from Goulburn to Yass, a distance of 56¼ miles, will be 380,930*l.*, or 6780*l.* per mile. The estimated cost of 46½ miles between Bathurst and Orange is 321,592*l.*, or 6916*l.* per mile. These estimates are based on the assumption that steel rails, weighing 70 lb. to the yard, will be used.

* From the *Journal of the Franklin Institute*. A paper recently read before the Franklin Institute. Being an examination of the method of applying pulverised fuel to furnaces and boilers invented by Messrs. Whelpley and Storer.

† In the year 1831, one J. S. Dawes took out an English patent for applying pulverised fuel to the blast furnace through the tuyeres. It proved unsuccessful, owing doubtless to the fact that the agency of fuel in the blast furnace is chemical as well as physical. In 1846 a patent was taken out by one Desboissiers, for pulverising fuel, and blowing the dust into the furnace, but though the conception involved some correct ideas, the machinery was totally impracticable. In 1854, Mouchel suggested the injection of powdered fuel and ores, either separately or together, upon a hearth, or inclined plane of a cast-iron box, heated by waste heat from other furnaces. Musket proposed, in 1856, to use pulverised coal, carried by the blast into a reverberatory furnace to prevent the oxidation of the iron. Other intermediate inventions have been patented in England but no progress made, owing to the difficulty of pulverising.

* It will readily appear that the lambent form of a genuine gas flame is better suited to communicate ignition than the scintillations of specks of fuel, where the flame would have to leap from grain to grain, over an intermediate space of cool or half heated air. It renders ignition more prompt and certain.

BAUSCHINGER'S INDICATOR EXPERIMENTS ON LOCOMOTIVES.

(*Continued from page 152.*)

(*c*) *Compression.* One of the peculiarities of the link motion consists in the premature closing of the exhaust. The period at which the escape of the steam in front of the piston is cut off before the latter has reached the end of its return stroke, depends upon the amount of angular advance of the eccentric, and also upon the amount of inside lap on the valve. This latter element, however, is less desirable for this purpose than in order to prevent an untimely opening of the exhaust port. As a natural consequence of this phenomena common to all valve motions with a single slide valve, the steam remaining in the cylinder at the instant when the escape is cut off, becomes compressed between the piston and the end of the cylinder,

Fig. 25

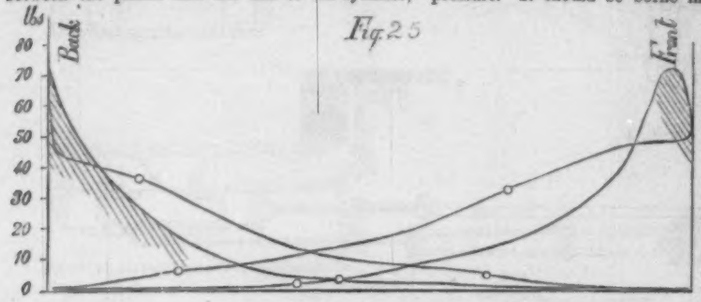
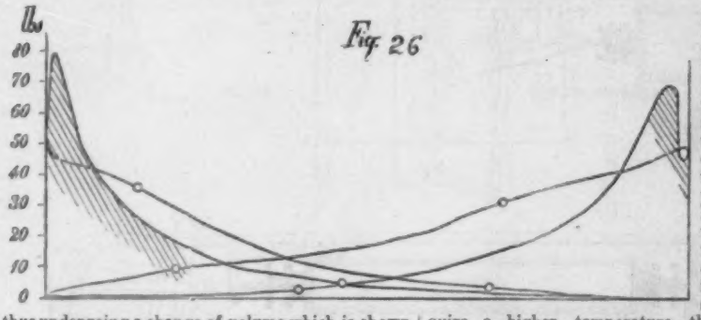


Fig. 26



thus undergoing a change of volume which is shown in the indicator diagram by a rapid rise of the line of back pressure. The amount to which the compression will rise is regulated by the capacity of the clearance space and the steam ways, but independent of these considerations, the back pressure, or rather the compression line, may rise—under special circumstances—much above the initial cylinder pressure and even above the boiler pressure, as we shall have occasion to show in the course of this article.

We have already seen that with the shifting link motion the lead increases rapidly as the link approaches mid-gear; but since increased lead produces also an increase in the effect of the inside lap on the valve, the amount of compression will, therefore, be correspondingly augmented towards mid-gear. An inspection of the indicator diagrams taken from locomotives having valves with the proportions commonly adopted in German practice, will show, in fact, that at high rates of expansion the period of compression extends over fully 50 per cent. of the length of the stroke. With the four engines, which we have already mentioned as being fitted with the double-valve motion, on the contrary, the compression has nearly been dispensed with altogether (see diagrams published on page 52 of the present volume), and the small amount of it which remains is constant for all degrees of expansion, as is also the pre-admission in all these cases. The work absorbed in compressing the steam before the piston is clearly shown by the area cut off from the indicator diagram, which, with the shifting link motion, bears a considerable proportion to the total area included in the diagram. At first sight this diminution of power would appear to constitute a direct drawback of the ordinary valve gear, and, in fact, the relative value or necessity of compression is very diversely appreciated by engineers; under the ordinary conditions of working, however, the compression afforded by a properly constructed shifting link motion is rather a valuable feature, and one of great importance for the smooth working of the locomotive engine. We shall now consider the advantages of compression in the order as demonstrated by Professor Bauschinger; in doing so, however, we have to risk the recapitulation of well-known facts.

In locomotives, the capacities of the clearance spaces and the steam ports are relatively larger than in most other steam engines, on account of the higher speeds of the former. These spaces must be filled at the commencement of the stroke, by high-pressure steam, which is obtained either by taking a supply of live steam from the boiler, or by compressing into the clearance spaces the low-pressure steam that still remained in the cylinder at the closing of the exhaust port. According to the latter process, a certain quantity of steam is saved at the expense of increased back pressure. It should be borne in mind, also, that the total heat of the compressed steam increases with its pressure, and as this latter approaches the boiler pressure the temperature of the steam in compression must also have been raised from that of about atmospheric pressure to nearer the temperature of the boiler steam pressure. These changes of temperature which the steam undergoes will affect the surface of the metal with which the steam is in contact during the period of compression; it follows from this that the ends of the cylinder principally comprising the clearance spaces must acquire a higher temperature than those parts where expansion only takes place. This is an important consideration, since the fresh steam from the boiler comes first in contact with these spaces, and by touching surfaces which have thus previously been heated, as it were, by the high temperature of the compressed steam, less heat will be abstracted from the fresh steam, and therefore a less amount of water will be deposited in the cylinder.

Another advantage offered by the employment of compression consists in the smooth working of the engine at high speeds; a circumstance which reduces greatly the wear and tear of the working gear. As the piston approaches the end of its stroke, the compressed steam forms a kind of elastic cushion, which is well calculated to absorb the momentum of the reciprocating parts at that instant. The pressure due to the momentum of these parts will, of course, depend upon their weight and the speed of working, increasing directly as the square of the speed. These data being given, the amount of cushion of steam, or the pressure which will be required to counterbalance the quantity of work stored up in the reciprocating parts, can easily be ascertained; it follows, from this, that the compression should decrease rapidly as the speed diminishes, and that it should be a maximum at high speeds. As we have seen before, this condition is fully accomplished by the shifting link motion.

We will next examine the relation which the actual curve drawn by the indicator bears to the theoretical curve of compression laid down according to the same laws as the theoretical curve of expansion. Figs. 23 and 24, on page 151 of the present volume, show two diagrams in which the theory of compression has been similarly developed as that of expansion. In Fig. 23, the line (– + – + – +) denotes Zeuner's theory, provided that the steam contained 40 per cent. of water; while the theoretical curve, according to Mariotte, is indicated by a dotted line (– – – – –). In Fig. 24, the latter curve only has been laid down. As will be seen, the departure of the actual curve of compression from the theoretical curve is equally wide as in the case of expansion, and here again the simple law of Mariotte, viz., the volume of the retained steam being inversely as the pressure, comes nearest to practical results. It will not be difficult to account for the phenomena that the indicated compressed curve should be below the assumed curves. During the period of exhaust the surfaces of the cover, piston, and cylinder have become materially cooled; when the exhaust port closes, the pressure and temperature of the retained steam rapidly rise; the temperature of the metal in contact with it rising simultaneously, but owing to the surface being large in proportion to the quantity of steam, a portion of the steam will be condensed. This loss of compression pressure is attended, on the other side of the piston, by a corresponding gain of total useful pressure, thus the departure of this curve, as well as that of the actual expansion line below and above the theoretical curves respectively, shows a proportional increase of the power exerted by the engine, which is clearly demonstrated by the increase of area included in the indicator diagram. The foregoing considerations induce Professor Bauschinger to conclude that although the value of compression will not be the same for all engines, the presence of this element is far less injurious to the economical working of the engine than would be anticipated by mere theoretical investigation; the evidence supporting this deduction will be further developed in the following chapters, when the duty given off by the steam in the cylinder will be considered.

It has been remarked at the beginning of this article that the line of compression will rise—under special circumstances—above the initial pressure; pre-supposing, of course, that the valve is so arranged that it cannot be forced off its seat. As examples of these phenomena we reproduce two diagrams, Figs. 25 and 26, taken from the second notch of engine D, the admission of steam being, at the hind cylinder end, 14 per cent., and at the front end, 27 per cent. of the length of stroke; the other data referring to these diagrams are contained in the subjoined Table:

No. of diagram.	Boiler pressure in pounds per square inch.	Initial pressure in pounds per square inch.		Revolutions per minute.	Regulator opening.	Blast pipe opening.	Maximum pressure of compression in pounds per square inch.	
		Hind end.	Front end.				Hind end.	Front end.
Fig. 25	74	44	46	162	¼ open	open	79	70
„ 26	48	42	48	159	open	¼ open	78	69

As illustrated in the annexed diagrams, the rise of the line of compression above that of the initial steam pressure produces a peculiar twisting of the indicator curve; of course, this action can only take place when the link is cutting off short, and when the amount of compression is consequently at a maximum, and to cause such an abnormal excess of the back pressure over the initial pressure, the latter must have been reduced either by the regulator being insufficiently opened, or by the boiler pressure having fallen considerably below its normal height. The effect of each of these causes is shown in Figs. 25 and 26. When the former diagram was taken, the boiler pressure was tolerably high, but the steam was being wiredrawn through an opening but one-fourth of the full regulator opening; in diagram Fig. 26, on the other hand, the regulator was fully open, the steam pressure in the boiler, however, had fallen to but 48 lb. per square inch. It is self-evident that this action in the cylinder is very objectionable, as involving a loss of effect; in computing the above diagrams, the area contained in the loop at the end of stroke, denotes negative work, as it were, and should be subtracted from the total area included in the indicator diagram. Provision should, therefore, be made, in all cases, to allow of the valve being slightly forced off its seat and thus affording an escape for the steam.

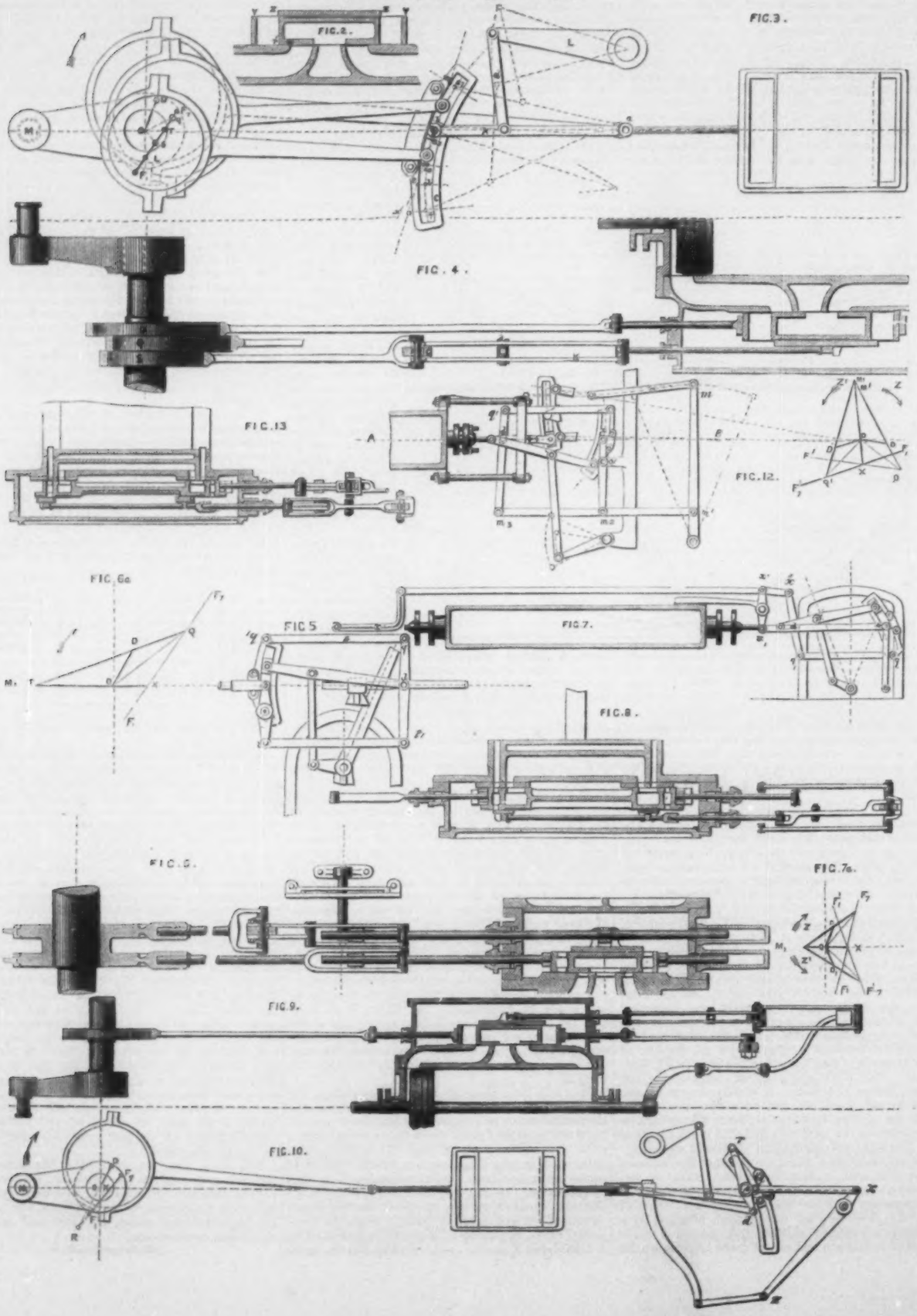
We have, thus far, completed our cursory examination as regards the form of the indicator curves obtained by Professor Bauschinger; the following paragraphs of our epitome will treat on the performance of steam and fuel, and on water and steam consumption.

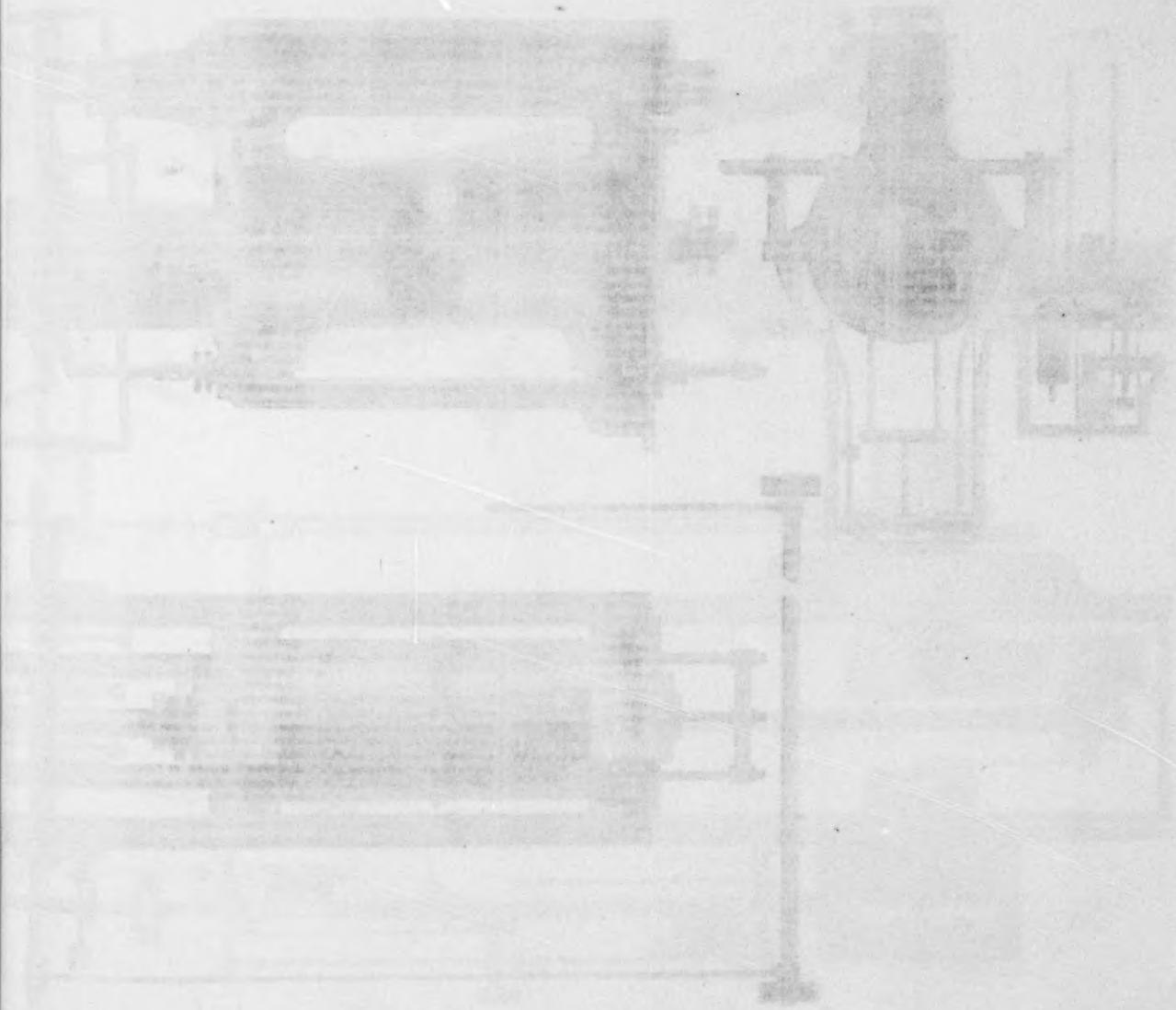
(*To be continued.*)

VARIABLE EXPANSION GEAR.

DESIGNED BY M. LUCIEN GUINOTTE, DIRECTOR OF THE MARIEMONT AND BASCOUP COLLIERIES, BELGIUM.

(*For Description, see opposite Page.*)

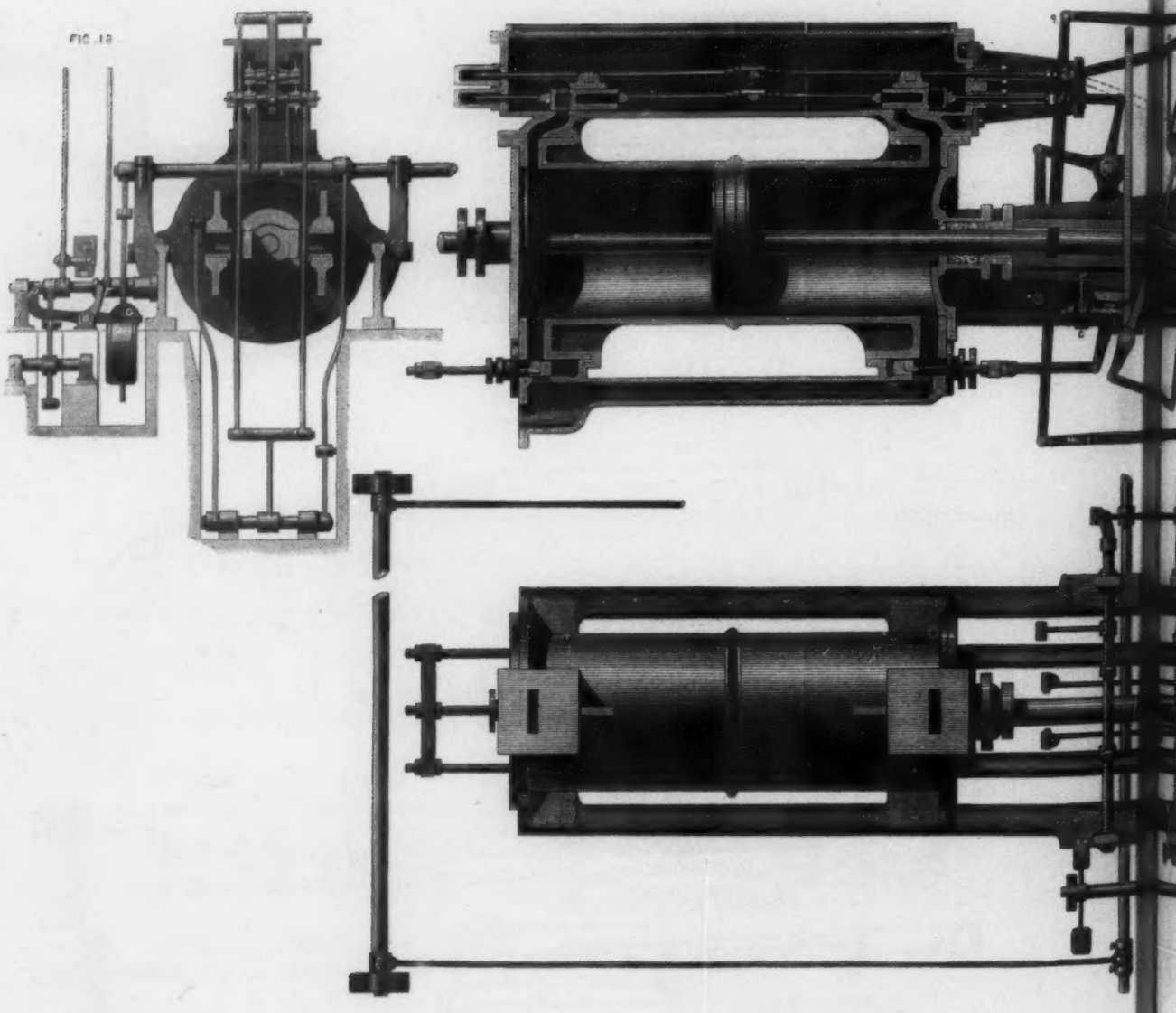




WINDING ENGINES WITH AUTOMA

DESIGNED BY M. LUCIEN GUINOTTE, MARI

(*For Description,*



ATIC VARIABLE EXPANSION GEAR.

RI[illegible]T AND BASCOUP COLLIERIES, BELGIUM.

[illegible] 201.)

FIG. 17.

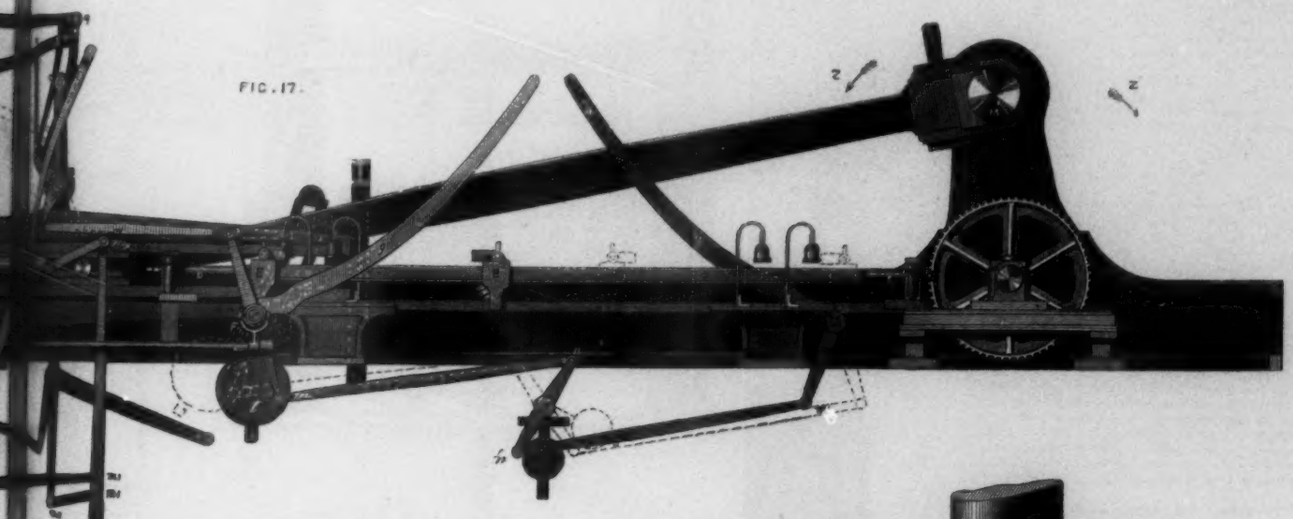
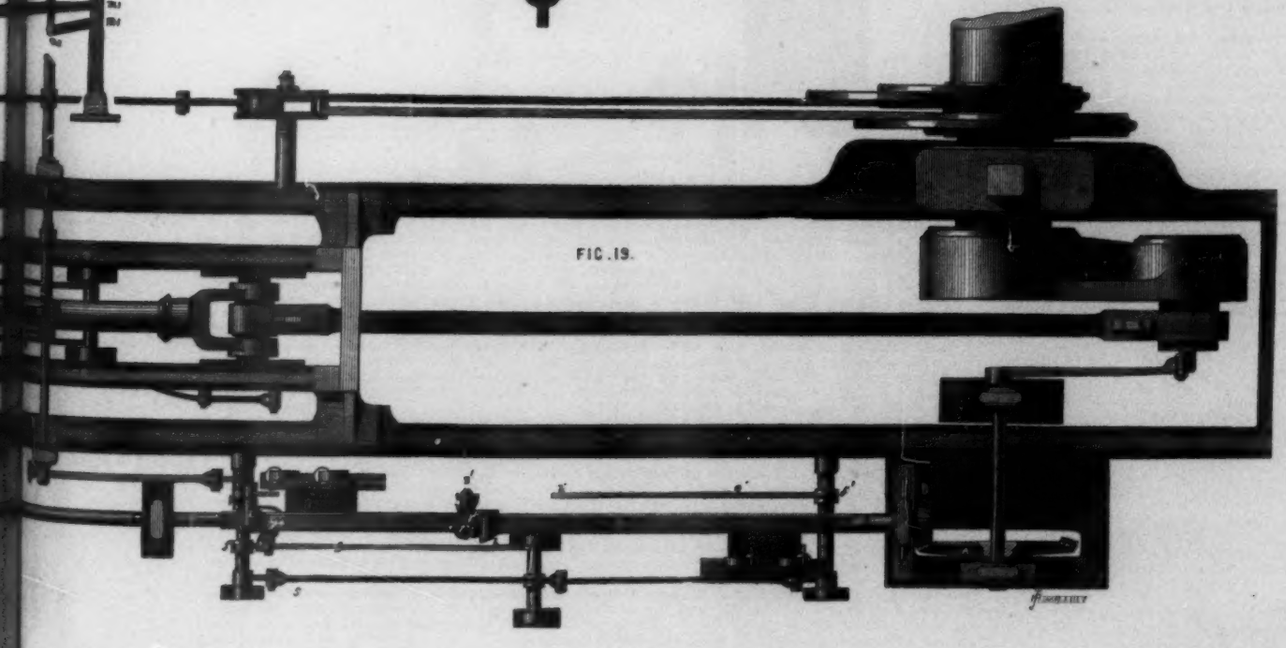
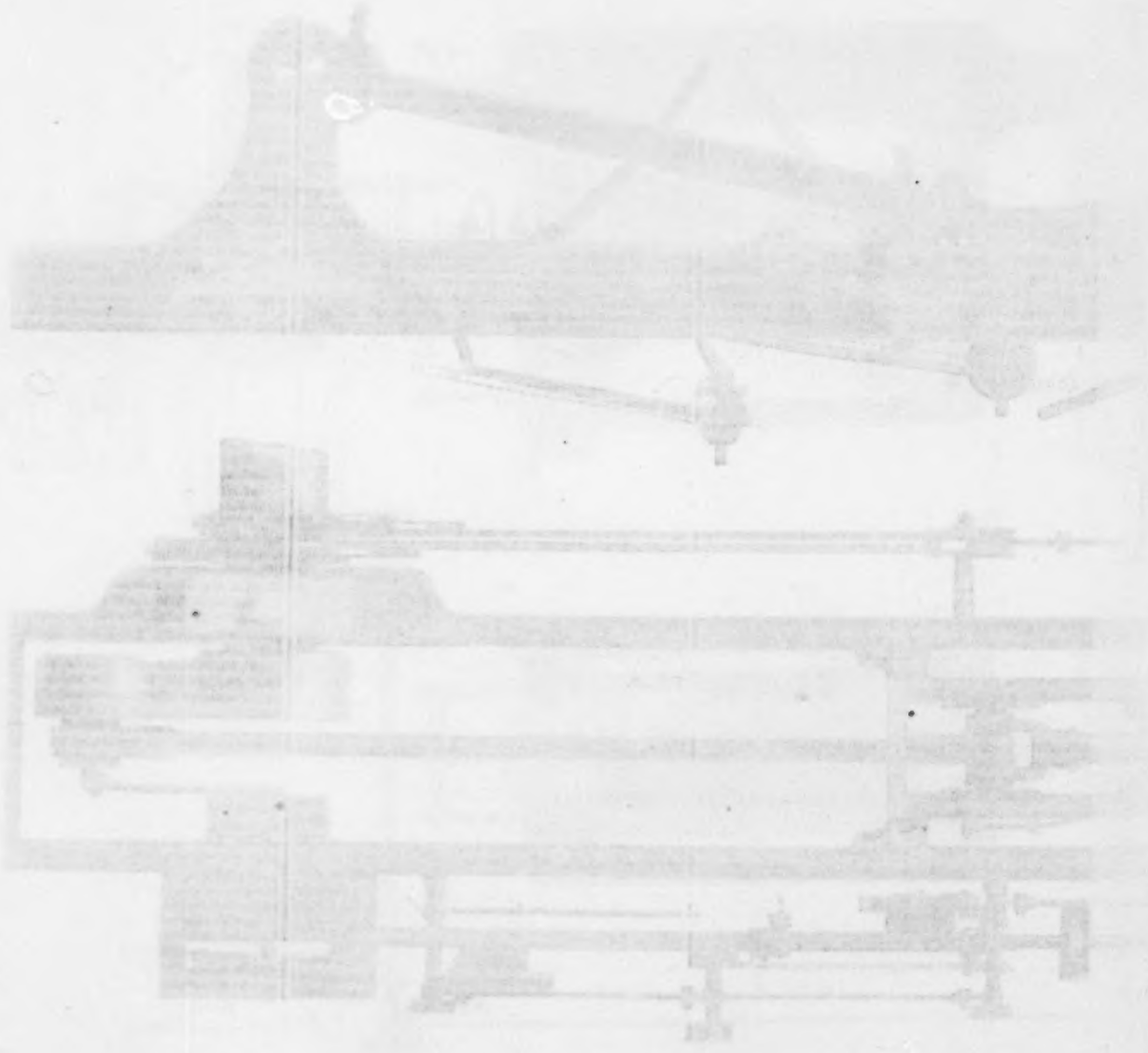


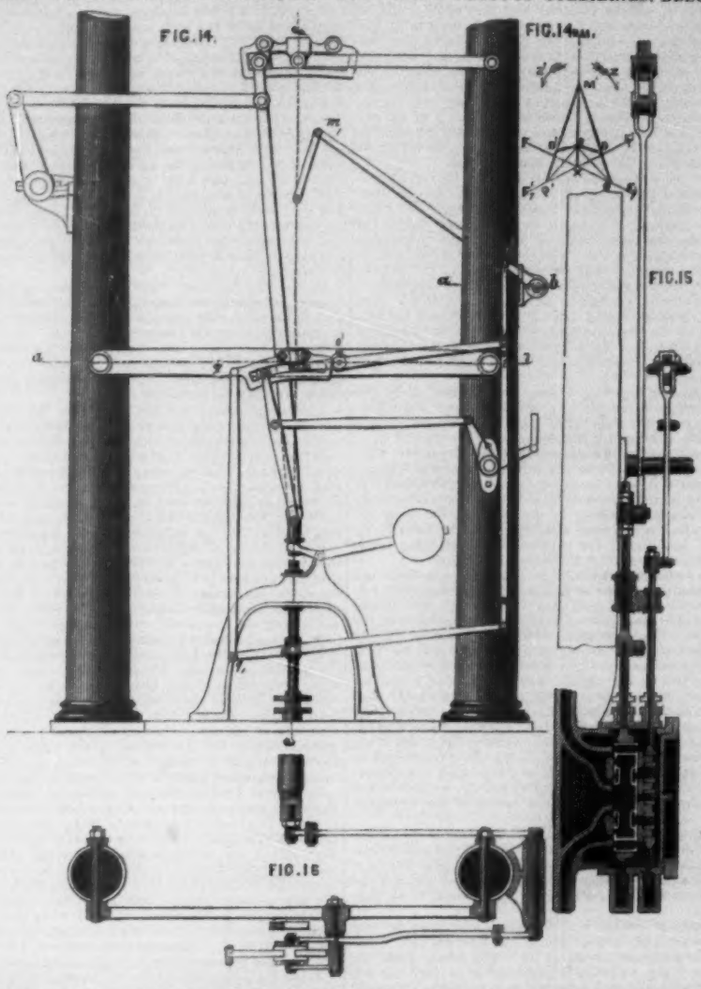
FIG. 19.





VARIABLE EXPANSION GEAR.

DESIGNED BY M. LUCIEN GUINOTTE, MARIEMONT AND BASCOUP COLLIERIES, BELGIUM.



AMONGST the exhibits to which we have referred briefly in our accounts of the International Exhibition, many of our readers will remember a very ingenious arrangement of variable expansion gear for winding engines of which a large model is shown in that department of the exhibition devoted to miscellaneous inventions. The expansion gear to which we refer is one designed by M. Lucien Guinotte, the director of the Mariemont and Bascoup collieries, Belgium, and we this week publish a two-page engraving showing a winding engine fitted with this gear, and also give other illustrations explaining its general construction and showing different applications of it. Before describing the winding engine with its gear in detail, it may be desirable that we should explain the leading features of M. Guinotte's plans.

The system of expansion gear designed by M. Guinotte is one which enables the point of cut-off to be varied from zero to full stroke, while it can be made suitable for an engine which is always running in one direction, or an engine which is reversed from time to time. The degree of expansion, also, may be adjusted either automatically according to the load on the engine or by hand. Referring to the illustrations it will be seen that M. Guinotte employs two slide valves, the one working on the back of the other, the second or expansion valve, being either made in one piece, or, if for convenience of construction it is made in more than one piece, the parts are connected so as to move together as a single piece, there being no variation of the distance between the edges of the valve.

Figs. 3 and 4, on page 200, represent the general construction of M. Guinotte's gear for an engine which is always run in one direction. In these figures the crank is supposed to be on the dead point at M_1, and the direction of rotation is indicated by the arrow. The main slide valve is driven by an ordinary eccentric having its centre at D, while the expansion valve has its motion communicated to it by a rod, *k*, which is jointed to the spindle of the valve at *a*, and is connected at *b* to a block sliding in the link, G. This link, G, has motion communicated to it, first, by being connected at *q*, to an eccentric having the eccentricity O Q, and keyed on the crank shaft so that its centre is at Q when the crank is at M_1; and, second, by being coupled at *s* to another eccentric having the eccentricity, O S, and which is keyed on the crank shaft so that its centre is at S when the crank is in the position just mentioned. The position of the sliding block in the link G, is governed by the expansion lever, L, this lever being coupled to the rod, *k*, by means of the link, *d*.

By comparing the diagram Fig. 1* with Fig. 3 on the opposite page, it will be seen that if the sliding block is at x_1, the admission will be *nil*, while if it is placed at x_2, the admission will continue for a period corresponding to a movement of the crank from M_1 to M_2, and thus it follows that the point of cut-off may be varied from zero to full stroke and any desired degree of expansion attained according to the position of the block in the link, G. In explaining further the details of this gear we shall follow the geometrical method so fully explained by Professor Zeuner, in his treatise† on valve gear.

In Fig. 1 let the eccentric by which the main valve is driven be represented by its radius, O D, the crank being supposed to be at M_1; and draw O *d* symmetrical with O D, with regard to the axis I G. Next upon O *d* as a diameter describe the circle, $a_1, a_2, a_3 \ldots$ having its centre at *o*; and with O for a centre describe the circle, $r_1, r_2, r_3 \ldots$ having a radius equal to the outside lap of the main valve. This lap is represented by $o'r'$ in Fig. 2, in which figure the centres of the valve and ports correspond. Draw the radius O Q, and when the crank is in this position the edge, r', of the main valve will cover the cylinder port by an amount equal to *r g*, Fig. 1, and the expansion valve may then uncover the port in the main valve without there being any danger of steam being readmitted into the cylinder after the cut-off had taken place.

From the same centre, O, describe a circle, $c_1 c_2 c_3, \ldots$ with a radius equal (see Fig. 2, page 200) to the distance between the face, Y, of the main valve and that marked Z on the expansion valve, when the centre lines of the two valves correspond. Next, from the middle point of O Q (Fig. 1), draw U W, perpendicular to O Q, and through the point, Q, draw $Q p_1$, parallel to U W. Join the point, *s*, to some point, J, in the line, $Q p_1$, and prolong this line by an amount, *s N*, equal to *s J*. Through the point, N, draw $N f_1$, parallel to the line, $Q p_1$, and draw the line, $F_1 F_2$, symmetrical, with regard to the axis, I G, to the line, $N f_1$, or $f_1 f_2$.

The line, $F_1 F_2$, being thus determined, it can be easily shown that if, instead of being driven by an eccentric having a radius and position fixed and invariable, the expansion valve derived its motion from an eccentric, of which the radius and position could be varied so as to shift the centre at will along a straight line, from F_1 to F_2 (in such a manner that, the crank being at O M_1, the lines joining, to the centre, O, the different points between F_1 and F_2, should express by their lengths and positions the radii of the variable eccentric), then the period of admission of the steam to the cylinder could also be varied at will through all the degrees between zero, and the maximum length of admission permitted by the main valve.

To find the position of the centre of the eccentric for any desired period of admission—for instance, the period represented by the angular movement of the crank denoted by $M_1 M_2$, in Fig. 1 (see note to preceding column), we proceed as follows:—Upon the radius, O M_2, and from the point, V, at the centre of O c_2, erect a perpendicular, V s_2, which will cut the line, U W, at the point, s_2. Join Os_2 by a straight line and prolong the latter to meet the line, $Q p_1$, at a point, p_2. Join *s* p_2, by a straight line and prolong this line to meet the line, $N f_1$, at f_2. From f_2, let fall a perpendicular upon I G, and prolong it so as to meet the line, $F_1 F_2$, at a point, F_2. This latter point will then denote the position sought for, that is to say, the centre of the eccentric should—in order that the steam may be shut off when the crank occupies the position, M_2—occupy the position, F_2, when the crank is at M_1.

The same process as that just explained has been followed with regard to the positions of the crank, O M_1 and O M_3, in order to determine the limits of movement, F_1 and F_3, which the eccentric ought to possess to be able to vary the degree of admission to the extent already referred to. In the same way also, operating upon the radius, O M_3, there has been laid down in Fig. 1 the position, F_3, which the eccentric driving the expansion valve ought to occupy to give the period of admission corresponding to the angular movement of the crank, $M_1 M_3$. The same process may evidently be followed for any degree of admission, it being merely necessary to take as a basis of operations the radial line marking the position of the crank at the moment when it is desired that the suppression of the steam shall take place. It may be remarked that the re-opening of the port in the main valve will take place for all degrees of expansion when the crank arrives at O Q—that is to say, when the cylinder admission port is closed, and when the edge r' (Fig. 2) has already passed beyond the edge *o* by a distance equal to *r g* (Fig. 1).

The system of expansion gear devised by M. Guinotte consists in a realisation of the variable expansion which would be obtained if the centre of the eccentric driving the expansion valve could be moved at will along this line, $F_1 F_2$ in the manner we have supposed above, this line being laid down by means of a diagram for each particular case in which it is intended to employ the system. This diagram gives for each degree of admission the minimum movement of one valve on the other.

To construct a variable expansion gear on the system above explained—and which consists in varying, according to a certain law, the angle and the radius of the eccentric by which the expansion valve is driven, or producing an equivalent variation in the gear which takes the place of such a variable eccentric—it is necessary to explain a second principle which not only forms the key to the system designed by M. Guinotte, but also explains all the combinations to which it gives rise, and the numerous arrangements which it enables to be obtained for each particular case which may present itself.

For this purpose we shall refer to Figs. 3 and 4, page 200, in which the crank is at M_1, and O Q and O S are the positions of the two eccentrics governing the movements of the points, *q* and *s*, of the link. Now if the eccentric rods, Q *q*, or S *s*, are sufficiently long, and if the curvature of the link is not too great (a state of affairs which can always be easily obtained by giving sufficient length to the rod, *k*, which determines the radius of the curvature of the link) there may, without appreciable error, be substituted for the geometrical movement of the arc, $x_1 x_2$, that of the straight line, *q s*, passing through the centres of the joints coupling the eccentric rods to the links.

It may then be easily demonstrated that any point, *t*, in the line, *q s*, dividing this line into two parts, *s t* and *q t*, will have the same motion as if it was driven directly by an eccentric having the radius and position, O T, the point, T, dividing the line, Q S, in the proportion:

$$Q T : T S = q t : t s.$$

We may, in the same way, determine the movements of other points, x'_1, l, x_1, &c. of the link by the proportions:

$$F_1 S : S Q = x'_1 : s q$$
$$L S : S Q = l : s q$$
$$S Q : Q F_1 = s q : q x'_1, \text{ &c.},$$

the results being that the points, x'_1, l, s, t, q, x_1, &c., on the line, *q s*, have respectively movements projected upon the line, O M'_1, from the points, F_1, L, S, T, Q, F_1, &c. If, then, the sliding block be so placed in the link as to correspond to the different points above named, the expansion valve will have imparted to it movements similar to those which would be communicated to it by eccentrics having their centres at corresponding points on the line, $F_1 F_2$. In other words, by shifting the block along the link the expansion valve will be made to receive movements varying in the same manner as if the centre of the eccentric by which it was driven was shifted along the line, $F_1 F_2$, the position of this latter line

* We much regret that in consequence of an accident to our engraving, we are compelled to postpone the publication of Figs. 1 and 11 until next week.

† *Traits des distribution par tiroirs dans les machines à vapeur fixes et locomotives; par G. Zeuner, Professor a l'école polytechnic fédérale de Zurich.* An English edition of this work has been published by Messrs. Spon.

being fixed with regard to the crank. The degree of expansion will then be variable between the broadest limits.

Figs. 5, 6, and 6a, on page 200, represent an arrangements in which a single eccentric only is employed to impart the desired movement to the link. The line, $F_1 F_2$, which M. Guinotte terms the "line of centres of the expansion eccentric," cuts the line of the dead points, M_1 O, at X. O D represents in all cases the radius and position of the eccentric for the main valve. An eccentric, O X, actuates the point, x, of the expansion link, and also the extremity of a lever, $x o t$, oscillating on the centre, o. The arms of this lever being in the proportion $o x : o t$, the point, t, receives a motion such as would be communicated to it by an eccentric, O T, of which the radius, O T, is in the proportion O T : O X $= o t : o x$. The movement of the point, t, is communicated by a rod, $t t'$, to the extremity of another lever, $t d q$, jointed at d to the spindle of the main valve, the point, d, thus participating in the movement of the main eccentric, O D.

Join T D (Fig. 6a), and continue this line until it meets the line $F_1 F_2$ at a point Q. The points, t and d, of the lever $t' d q$ being actuated by the movements of the eccentrics T and D, a third point, q, so situated that $q\,d : d\,t' = $ Q D : D T will have the same motion as would be communicated to it by the eccentric, O Q; and if there is conveyed, by means of the rod, b, this motion of the point, q, to the point, q', of the link it will be seen that the same effect is obtained as if the point, q', of the link was coupled direct to an eccentric, O Q.

Figs. 9 and 10 on page 200 represent an arrangement in which no expansion eccentric is required. The point, X, marking the intersection of the lines, $F_1 F_2$, and O M_1 (see Fig. 6a), is still adopted as the "centre of command," but the eccentric having its centre at this point is replaced by a lever, $m o z$, of which the end, m, receives its motion from the piston rod. M_1 O being the radius of the crank it is sufficient, evidently, to adopt for the lever the proportion M_1 O : O X $= m o : o z$.

The lines, O D and $F_1 F_2$, intersect at R. If a second lever, $d\,o'\,r$, oscillating on a fixed point, o', receives at the extremity, d, the movement of the spindle of the main valve—that is to say, if it is driven by the eccentric D—the other extremity, r, will receive the same motion as if it was driven by an eccentric, R, provided the proportions of the lever are such that O D : O R $= o' d : o' r$. Then x and r will be the two points of the expansion gear which will represent the movements of the line $F_1 F_2$.

The examples of M. Guinotte's gear which we have so far considered are applicable to engines which are continually run in one direction; we have now to describe the system as applied to engines fitted with reversing gear, and for this purpose we shall refer in the first place to Fig. 11.

In this figure* the crank being at M_1, the main eccentric for motion in the direction Z, is situated at D, and that for motion in the direction Z' at D'. Regarding the movements in the two directions independently, that is to say, treating each of the eccentrics, D and D', separately in the manner followed when considering the case of an engine moving in one direction only (Fig. 1), we find a line of centres for the expansion eccentric for each direction of motion; the line $F_1 F_2 F_3 \ldots F_7$ being for motion in the direction Z, and $F'_1 F'_2 F'_3 \ldots F'_7$ for that in the direction Z'.

The lines $F_1 F_7$, $F'_1 F'_7$ cut the line of the dead points, M_1 O,—this being a prolongation of the radius of the crank—at the point X; and one of the points of the link can thus be actuated by a movement identical with that which would be imparted to it by an eccentric, O X, and the movement of this point will apply equally to the motion of the engine in either direction, Z or Z'. This movement can be obtained either by an eccentric as in the arrangement shown by Figs. 5 and 6, page 200, or by an attachment to the piston rod as in the arrangement shown by Figs. 9 and 10, on the same page, or by some other combination of parts.

The difficulty to be overcome in designing a valve gear of this kind thus resolves itself into providing such a means for actuating a second point of the expansion link as will enable the motion imparted to that link to be modified to suit the direction in which the engine is running. This difficulty disappears if the second point of the link is actuated by such means that the nature of the movement imparted to it is altered simultaneously with the reversal of the engine. In order that this may be the case it is sufficient to turn to account the motion of the spindle of the main valve.

Let us consider, for example, the arrangement shown by Figs. 7, 8, and 7a. In this case the two eccentrics for the main valve are O D and O D', the "lines of centres" for the expansion eccentric for the two directions of motion are respectively $F_1 F_2$ and $F'_1 F'_2$; and an eccentric, O X', governs, in the first place, the joint, x', of the lever, $x' o z_1$, which oscillates on the fixed point, o. The proportions of the arms of this lever being such that O X' : O X $= o x' : o z_1$, a movement corresponding to that of an eccentric, O X, is obtained at z_1, and consequently at the point, x, of the expansion link which is connected to the lever by the rod $z_1 x$. In the second place the eccentric, O X', gives motion by means of the rod $x' x''$ to the extremity, x'', of a second lever, $x'' d q_1$, which is connected at the point, d, to the spindle of the main slide valve. Under this arrangement the point, d, of course, has the motion imparted by the eccentric, O D, when the engine is running in one direction, and that given by the eccentric, O D', when the motion is reversed.

The two arms of the lever, $x'' d q_1$, having given to them the proportion, X' D : D Q $=$ X' D' : D' Q' $= x'' d : d\,q_1$, it will be seen† that the extremity, q_1, of the lever—and, in consequence, the point, q, of the link to which the lever is connected by the rod, $q_1 q$—will, when the main valve is driven by the eccentric, O D, have a movement similar to that which it would derive from a direct connexion with an eccentric having the radius and position, O Q; while, when the main valve is driven by the eccentric, O D', the motion of the point, q_1, will be identical with that which would be given to it by direct attachment to an eccentric with the radius and position, O Q'. The line connecting the two points of attachment of the link x and q thus represents the line, X Q, when the engine is running in the direction, Z, and the line, X Q', when the motion is in the direction, Z'. In other words, it will be seen that by moving over the reversing lever the motion imparted to the point, q, of the expansion link will be changed, and the link will be made to represent the line, $F_1 F_2$, or the line, $F'_1 F'_2$, according to the position which the reversing lever occupies.

We give yet another example in Figs. 14, 15, and 16, and the diagram Fig. 14a, on page 201. In this arrangement there is no special eccentric for the expansion valve. The joint, m_1, of the lever, $m_1 m' o$, derives its motion from the piston rod, and the two arms, $o m'$, $o m_1$, being in the proportions given by the equation, $o m' : o m_1 = $ O M' : O M_1, it will be seen that the point, m', and in consequence the two points, m_2 and m_3, receive the motion which would be imparted to them by a direct attachement to an eccentric, O M'. The point, m_3, is situated on a lever, $m_3 o' x$, of which the two arms are in the proportion, $m_3 o' : o' x = M' O : O X$, from which it follows that the point of attachment, x, of the expansion link has a motion such as would be given to it by an eccentric, O X.

A third lever, $m_2 d\,q_1$, having its fulcrum, d, on the main valve spindle, and having its arms in the proportion, $m_2 d : d\,q_1 = M' D : D Q = M' D' : D' Q'$, carries the motion to the point, q, whence it is communicated by the rod, $q_1 q$, to the second point of attachment, q, of the expansion link, this point having thus a motion similar to that which would be imparted to it by an eccentric, O Q, during the motion of the engine in the direction, Z, and by an eccentric, O Q', when the engine is running in the direction, Z'. Thus the expansion link in this case, also, represents the lines $F_1 F_2$, or $F'_1 F'_2$, according to the position of the reversing lever, and the direction in which the engine is running.

We may remark here that if the reversing lever should not happen to occupy the one or the other of its extreme positions, no inconvenience will result, and the expansion will remain variable within the limits allowed by the proportions of the main valve. It will be seen, from what has been already stated, that when an engine fitted with the gear we have described is reversed, not only is the movement of the main valve modified in the required manner; but the conditions under which the expansion valve acts are at the same time altered to suit the change in the direction of rotation of the crank shaft without causing any additional trouble to the engine man. In fact, the lever governing the action of the expansion valve need only be touched when it is required to vary the point of cut-off, and if the expansion gear is once set to any desired cut-off the engine can be reversed to and fro without interfering with the action of the expansion valve.

Figs. 12 and 13 on page 200, and Figs. 17, 18, 19, of our two-page engraving represent two engines fitted with reversing gear to which M. Guinotte's expansion gear has been applied in a manner identical as to principle and general arrangement with that shown in Figs. 14 and 15 on page 201.

The point of cut-off can, if desired, be made to vary continuously and automatically, an arrangement which it is advantageous to adopt in cases when, from the resistance being variable, it is desirable to vary the admission of steam in such a manner as to maintain a constant equilibrium between the power developed and the work to be done. Such a case, for instance, is that of winding engines for mines, &c. Let us take, for example, a winding engine in which the law governing the variation of the work to be done at each revolution is known, and in which, consequently, the degree of expansion to be employed at each revolution can be ascertained. In this case the block, instead of being shifted in the expansion link by hand, can have its position adjusted by the engine itself, as shown by Figs. 17, 18, and 19 of our two-page engraving.

Referring to these figures, it will be seen that the rod, $k\,i$, carrying the block, k, is supported by being jointed to a sustaining link, $a\,b$, this latter link being attached at b to a lever, $b\,c$, keyed on the shaft, c, on which there is also fixed the lever, $c\,d$. By means of the connecting link, $d\,a$, the lever, $c\,d$, is coupled to another lever, $e f$, keyed upon a shaft, f, which also carries the curved lever, $f g\,h$. The position of the sliding block in the expansion link is thus dependent upon that of the curved lever just mentioned.

Another shaft, f', carries another curved lever, $f' g' h'$. The two levers, $f g\,h$ and $f g' h'$, are connected to each other by the levers, $f m$ and $f' m'$, the rods, $m n$ and $m' n'$, and the double lever, $n p n'$, the connexion being thus such that the curved levers, $f g\,h$ and $f' g' h'$, move symmetrically. A counterpoise, l, placed at the end of a lever, $f l$, tends to maintain the whole system of levers of which we have just been speaking, in the position in which they are shown by the full lines in Fig. 17, this position corresponding to the full admission of the steam.

The crank shaft, by means of the bevel gear, A B, gives motion to the screw, C D. This screw carries two nuts, of which the one, E, is provided with a small lever, $r s$ (see plan, Fig. 19), which is pivoted so that it can turn from left to right, but not from right to left. This lever, $r s$, carries a small friction roller, t, which is situated in a line with the curved lever, $f g\,h$. The other nut, E', is in like manner provided with a lever, $r' s'$, this lever carrying a friction roller, t', which is in a line with the curved lever, $f' g' h'$.

The arrangement is such that when the engine is running in the direction shown by the arrow, Z', in Fig. 17, the two nuts, E and E', which cannot turn with the screw, C D, have imparted to them a rectilineal movement from left to right. Under these circumstances, the friction roller, t, presses upon the lever, $f g\,h$, and causes it to be moved downwards towards the position shown by the dotted lines, the sliding block, k, being, of course, at the same time moved down in the expansion link and an earlier cut-off of the steam produced. Eventually the system of levers will occupy the positions shown by the dotted lines, this taking place three or four revolutions before the cage, which is being lifted by the engine, arrives at the bank level. A little later, just before the end of the lift, the friction roller, t, clears the end of the lever, $f g\,h$, and disengages it, when the counterweight causes the whole system of levers to assume the positions shown by the full lines, thus giving the steam admission for full stroke. While the operations above described have been going on, that is, while the nuts, E and E', were moving from left to right, the friction pulley, t', on the lever connected to the latter nut will have encountered the lever, $f' g' h'$. This lever, however, will approach the roller from above and from the right hand side, and lever $r' s'$, by which the roller, t', is carried being pivoted so that it can turn from right to left, it will yield to the pressure of the lever $f' g' h'$, and will on passing that lever be caused to resume its normal position by the spring shown in the plan. In this way the roller, t', will be changed from a position below to one above the lever, $f' g' h'$.

During the following "lift" the engine will run in the direction shown by the arrow, Z, and the screw, C D, will thus be turned in the opposite direction to that in which it previously run and the two nuts, E E', will thus be caused to move from right to left. Under these circumstances the friction roller, t', will operate upon the lever, $f' g' h'$, in the same manner as the lever, $f g\,h$, was operated upon by the roller, t, during the preceding lift.

During the successive "lifts," therefore, the degree of expansion will be varied according to the same law whatever may be the direction in which the engine is running, so long as the two levers, $f g\,h$, $f' g' h'$, are made to the same curve, as will ordinarily be the case; but, if circumstances should render it advisable, the degrees of expansion can be varied according to different laws in the alternate lifts simply by modifying the shape of the levers just mentioned. Such a case might occur, for instance, when an engine was used to work two drums of different diameters making lifts alternately from two shafts of different depths. It is evident that the curvature to be given to the levers, $f g\,h$ and $f' g' h'$, has to be determined by an investigation of the degree of expansion admissible during each revolution, and this investigation will be a special one for each particular case.

In the engine shown by our two-page engraving the screw, C D, is also employed for actuating the bells which indicate the position of the cage which is being raised, these bells being arranged as shown, and the nuts, E E', being provided with striking pieces which come into contact with the bells at the proper points towards the end of each lift. Moreover, as the movements, to and fro of the nuts, E E', correspond with the rise and fall of the cages in the mine, the engine man in charge at all times has the means of knowing the exact positions of the cages in the shaft.

In case of accident, the engineman, by placing his foot upon the pedal, P, can suddenly admit full steam to the engine. The lever, $e f$, in place of being keyed rigidly upon the shaft, f, is connected to it by means of the clutch, F (see Figs. 17 and 18), which is actuated by the pedal, P. On this pedal being pressed by the engine man, the clutch just mentioned is disengaged and the sliding block, k, rises to the top of the expansion link under the influence of the counterweight, l. On the other hand, when the pedal is released, the clutch is thrown into gear again by means of the counterweight, G, the moment the system of levers assumes the positions corresponding to a full admission of the steam.

From the particulars which we have given above, it will be seen that M. Guinotte's system of expansion gear possesses great ingenuity and is capable of a wide range of applications. In the case of winding engines, it affords a perfect means of automatically adjusting the degree of expansion to the resistance at all parts of the lift, while, at the same time, the engineman can at any time at once apply full steam if it should be necessary to do so. In the case of engines having the winding drums proportioned so as to give a sensibly constant resistance, the arrangement for varying the expansion as last described would not be required; but a constant degree of expansion may be used throughout each lift, simple means being employed by which the engine itself is caused to place the gear into the proper position for admitting full steam shortly before the cage which is being raised "comes to bank." Even in cases where the resistance is not uniform, some engineers prefer to employ a constant degree of expansion carried out in this way. It is probable that at some future time we may have more to say respecting the results of the application of M. Guinotte's gear to other classes of engines; but for the present, we must conclude by acknowledging the courtesy with which M. Guinotte furnished us at our request with the series of tracings, explanatory of his system, from which the various diagrams and engravings we publish have been prepared.

New Works.—One of the blast furnaces at the Lackenby Iron Works, Middlesbrough, has been blown in this week, and the other will be ready for blast on Saturday.

Spanish Ore.—Spanish ore continues in considerable demand in South Wales, and were it not for the deficiency of shipping facilities at Bilbao and the consequent high rate of freights an immense business could be done.

Rogers's Life-Saving Projectiles.—A subscription has been formed for the purpose of meeting the expenses necessary for testing Rogers's life-saving apparatus at different points around the coast during the approaching winter. The value of the apparatus has already been proved at various Government trials, and at a recent meeting of the members of the Royal Yacht Squadron, opinions were unanimous about its utility, and a testimonial to that effect was given to the inventor.

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* See foot-note on the preceding page.

† By an accident the letters Q and Q' have been omitted from fig. 7 a. The former letter should be placed at the intersection of the F_2 F_3 with the extension of the thick line drawn through the point D, while the letter Q' should be situated at the intersection of the thick line drawn through the point D', with the line F'_2 F'_3. The letter X', also, should appear at the point of meeting of the thick lines drawn through the points D and D'.

COMPOUND MARINE ENGINES.

TO THE EDITOR OF ENGINEERING.

SIR,—In last week's ENGINEERING Mr. McFarlane Gray endeavours to show that if the calculations of coefficients given with the diagrams of Messrs. Richardson's compound engines were correct, that "these engines would be an advance upon perfection." It will be found, however, that his conclusions are based on erroneous assumptions.

He states that "the total ratio of expansion calculated from capacities of cylinders and pressure, as cut off is high, is eleven times." Whereas, in order to obtain theoretical results, it should be put thus: The total expansion calculated from the actual initial pressure, measured in high-pressure cylinder (70 lb. above zero), and the mean final pressure in low-pressure cylinder (4.675 lb.) is 14.5 times. The coefficient due to such an expansion, and under mathematical conditions, is $1+\text{hyp. log. } 14.5=3.68$ corresponding to a mean absolute pressure of 17.94 lb. per square inch, or about 11 per cent. more than actually realised. The coefficient of perfection is, therefore, 3.68, and not 3.154, as Mr. Gray makes it; for the existence of 1½ lb. or any amount of back pressure, is certainly not consistent with perfection.

The highest possible coefficient, therefore, after deducting the greatest cause of imperfection, namely, the back pressure, would be $\frac{17.94-1.25}{4.675}=3.424$.

Further on, with reference to measuring the quantity of steam expended at each stroke, Mr. Gray says: "The best point to take it is a little before the exhaust in the high-pressure cylinder." Now this is entirely a matter of opinion, and it will depend on various circumstances whether a correct measure of the steam expended can be obtained there. Thus if the boiler were priming, or even supplying moist steam, and especially in the case of an unjacketted high-pressure cylinder, a quantity of water would be carried through with the steam, which could not be measured at that point. This water would, however, be either wholly or partly evaporated in the intermediate receiver, and at least, in all ordinary cases, would be wholly evaporated at the final point of expansion in the low-pressure cylinder, and could therefore be correctly measured there.

As a general rule, therefore, however fairly a comparison of the efficiency of different engines may be made by Mr. Gray's method, it cannot be used to challenge the accuracy of the other method, which, though differing in results, is fully as convenient for obtaining comparative coefficients of efficiency.

Further than this, the difference between the coefficients, as obtained by the two methods, is very much overstated by Mr. Gray. Thus, if instead of using the rough rule of pressure × by volume as constant, he had taken the presumably correct formula for dry saturated steam, expanded in jacketted cylinders ($P_1 v=P_1 R^{-\frac{1}{14}}=35.8\times5.85^{-\frac{1}{14}}=5.48$), he would have found the final pressure (due to the initial pressure and rate of expansion assumed) to be 5.48 lb. instead of 6.125, and $\frac{16.167}{5.48}$ (I take the mean pressure, calculated in the usual way, to be correct), gives a coefficient of 2.95; and allowing for the clearance and ports of the low-pressure cylinder, which the cushioned steam scarcely fills up to final pressure, the coefficient becomes approximately 3. This accounts for more than half the difference found by Mr. Gray between the two methods, and brings them at least within reasonably explicable discrepancies.

I am, yours respectfully,

Hartlepool Iron Works, CHAS. SMITH.
Sept. 27, 1871.

THE RIGHTS OF INVENTORS.

TO THE EDITOR OF ENGINEERING.

SIR,—I have read with complete concurrence your article on the above subject in your issue of the 15th instant. I purposed sending you a few remarks on this very important matter, and only refrained because you had rendered the bulk of my opinions so much more ably than I could have done myself.

I cannot, however, pass over without a few remarks the letter by "Cyclops," appearing in your last issue; and though your very pregnant little foot-note to that gentleman's poetical communication is a fitting summary of all that need be said in reply to him, his letter is suggestive of arguments which may not occur to the general public.

The argument that, because an inventor must invent, therefore his inventions should be taken from him for the public good will hardly bear looking into. Let us take a parallel case. Because a man has an orchard which will bear apples at a certain season, is he therefore to give them away, and not take them to market and sell them at their market value? The inventor's brain is his orchard, and its fruit are his apples, and not seldom the only marketable commodities he has; he can't live entirely on his apples, and he has a great many more than he can by any means consume himself—what is the poor fellow to do if the law declares the apples public property as soon as they appear on the tree? He will probably build a high wall round his orchard, and buy a revolver, and keep a big dog, and then if the public won't pay for his apples, why they will have to go without them!

Probably the "political change" which made all fruit common property would have its "antagonism tarnished" in a similar way to that so eloquently and mistily set forth by "Cyclops."

The next point that strikes me as peculiarly quaint is this. Your correspondent says: "Public money granted to secure a private end is a political wrong." Who said it was not? and who wants to grant public money except those who would in that way reward inventors? Inventions never fetch more than they are worth, for the market is open to all, and no one can be compelled to buy. If the public does not gain by buying, the public need not buy, and if the public gains by buying, who is so mean as to grudge the inventor a fair price for his labours? and who, after a moment's consideration, can endorse so utter a misapplication of terms as those words of your correspondent which I have quoted above?

As to the difficulty of "defining a claim," does not your correspondent create this difficulty by upholding a system of State awards? Give the inventor a property in his inventions, so that he can take his claim into the market, and it will adjust its own value, as surely as water will find its own level.

Lastly, I fear I am trespassing too much on your space, but I must ask to be allowed to make one remark on the "embossed sores" which Mr. Wise's pen has very properly brought to light. In my opinion it would be as reasonable to insist on killing Mr. Cyclops if he should ever be troubled with an "embossed sore," as it would to deprive an inventor of protection altogether because the present law is not all it ought to be. There is good reason for reforming the Patent Laws, so that the inventor may have his rights without being so heavily taxed; and there is reason for reforming that system which grants a man a patent which is no patent, and takes the poor man's money for naught. But these grievances are the grievances of the inventors, and the ill-used public, whom Mr. Cyclops has so much at heart, are indirectly benefited by the injury inflicted on the individual "whose mighty current and compulsive course ne'er feels retiring ebb."

Yours very obediently,

JULIUS P. M. POLLOCK.

Lonclose Works, Newtown, Leeds,
September 26, 1871.

TO THE EDITOR OF ENGINEERING.

SIR,—I should not have troubled you with any remarks upon the long and, to me, unpractical letter of "Cyclops" in last week's ENGINEERING, especially as he writes anonymously, which I regard as a sign of weakness, had he not thought proper to refer in such disparaging terms to my paper on the patent laws. You have published at least a couple of my papers on this subject, read respectively to the Society of Engineers in 1870, and to the London Association of Foremen Engineers and Draughtsmen this year—hence I cannot tell which paper your correspondent alludes to, and am therefore prevented from entering fully into the question until he treats it more specifically.

As you very justly say, in your excellent leader of the 15th inst., "There was never yet any institution free from weakness, not able to be abused," and so it would be idle for the defenders of inventors' rights to pretend that the present state of our patent laws is wholly satisfactory. On the contrary, while maintaining the fact that more good than evil has resulted from the existing system, they nevertheless freely admit its shortcomings, and propose those remedies which their practical experience may have suggested to them.

In conclusion, I may refer to the discussions on my papers in proof of the fact that my views do not lack the support of those whose opinions deserve attention.

Yours obediently,

W. LLOYD WISE.

September 27, 1871.

RAILWAY GAUGES.

TO THE EDITOR OF ENGINEERING.

SIR,—Having long satisfied myself both by experiment and practice of the enormous economy of the narrow gauge compared to the broad in *every* department of its working, I nevertheless seek for confirmation in all available quarters.

I consider the enclosed letter, which I ask you to kindly publish, contains the most satisfactory proofs of the great truths I have given forth to the world; satisfactory, because it is from a man, than whom it is well known few, if any, have had a greater or wider experience in the construction, working, and maintaining of carriage and wagon stock, and who, at this moment, is maintaining alone, exclusive of the enormous number building *every day*, some 12,000 wagons.

Nothing, certainly, could be more interesting to learn than this, and it will be no longer matter for wonder to know how that, which is now termed the broad gauge (but soon to be changed, I trust), could have lifted its head so rapidly as it has done of late. Its improvement can be measured almost with every mile of the narrow substituted for the broad gauge.

Can there be a more conclusive or striking illustration than this?

Your obedient Servant,

ROBT. F. FAIRLIE.

9, Victoria-chambers, September 28, 1871.

(COPY.)

Gloucester Wagon Company, Limited,
Gloucester, Sept. 21st, 1871.

R. F. Fairlie, Esq.

Dear Sir,—Referring to the conversation that I had with you yesterday on the comparative merits of broad and narrow gauge railways, so far as that question affects the cost of construction and maintenance of rolling stock, I don't think I can give you my opinion in a more forcible manner than by relating what I said to Mr. Potter, when he was made Chairman of the Great Western Railway, now about eight years ago, and now President of the Grand Trunk Railway of Canada.

I recommended Mr. Potter in the strongest terms I could use to commence the conversion of the broad gauge into narrow; by "narrow," I mean, of course, the established gauge of the country, 4 ft. 8½ in. I followed up the advice by one or two illustrations; for instance, I said if a colliery proprietor applies to me for terms for the hire of 10-ton broad gauge wagons and 10-ton narrow gauge, I should ask 18*l.* a year for the former, and 12*l.* for the latter, and I should use all my influence to persuade him to take the narrow gauge. I then said this applies to wagons that always carry a full load, but if you apply the same mode of comparison to merchandise wagons, as used by railway companies, you will find the difference still more striking, and especially so when applied to "dead weight" and "paying weight." For instance, it is found that on narrow gauge railways which pass through the manufacturing districts, the average load of a *loaded wagon* does not exceed 30 cwt.; if this is so on those lines which serve the manufacturing districts, it is scarcely to be expected that you would get a better result on the broad gauge system, which passes through an agricultural district. What then is the result? Simply this: you have got on the broad gauge wagons, the first cost of which, and the cost of maintenance, is so largely in excess of the same items on the narrow gauge, but you have also, on the broad gauge, a dead weight of from 5 tons 10 cwt. to 7 tons, for a paying load of 30 cwt.; on the narrow gauge you have a dead weight of 3 tons 10 cwt. to 4 tons, for the same paying weight.

The above is in plain words the conviction which I had formed, and which I expressed to Mr. Potter eight years ago, and I have seen no reason to alter my views.

Yours faithfully,

(Signed) J. SLATER.

MACNAIR'S PERMANENT WAY.

TO THE EDITOR OF ENGINEERING.

SIR,—I have the pleasure to inform you that my patent invert permanent way, which was noticed in your issue of May 19th, has been laid down for trial in the goods station of the North London Railway, at Poplar. The traffic at this place is very great, and it is said that engines with or without wagons pass over it about 100 times a day. It is also on a steep incline, which makes it more severe on the road. The North London use the same rails as on their passenger line, viz., steel rails 5½ in. deep, and 80 lb. per yard.

The trial invert road consists, 1st, of 72 ft. of steel rails 4½ in. deep, and 70 lb. per yard, which it is hoped will last so long as to prove that the longest-lived rail may be worn out before the invert substructure requires repair. Next to this, 2nd, are laid 40 ft. of iron rails 4½ in. deep, and 66 lb. per yard, the object of which is to prove that a rail of very ordinary strength will be made capable of performing much harder work by the use of the invert substructure. To test this point still more accurately, 3rd, there are 20 ft. of iron rail of the same section laid on sleepers, which it is hoped will be comparatively speedily worn out under the heavy traffic, should no accident occur in the mean time to interfere with the experiment.

The reasons for using rails of so much less depth and weight than those of the North London Railway are twofold. In the first place, it was necessary to procure flat-bottomed rails, of both steel and iron, of nearly the same section, which had the effect of limiting the choice. And in the second place, the great elasticity, which is a very striking feature of the invert road, is much more apparent when the rail is not very deep. There is, no doubt, a certain degree of stiffness in the rail which, under certain conditions of traffic and substructure, will produce the best results. Without, therefore, presuming to decide that 4½ in. is the proper depth in this case, I may be permitted to observe that in my opinion a depth of 5½ in. would be less suitable for the invert road. And if the lesser depth be preferable for construction, it has also the advantage of economy.

This trial line also shows the extreme smoothness of motion on the invert road, which may be practically tested by riding on an engine or wagon, and proves by inference the benefit it would confer by increased durability of the rolling stock.

I am, Sir, yours truly,

ALEX. H. MACNAIR.

2, Westminster-chambers, September 26, 1871.

DEFINITION OF "ENGINEER."

TO THE EDITOR OF ENGINEERING.

SIR,—There is one thing in connexion with the Newcastle strike which cannot, I think, have failed to attract the attention of every engineer who has the true position and interest of the engineering profession at heart.

To nine-tenths of the public the title of engineer is much the same, whether applied to Sir William Armstrong or the fitter, smith, and boiler-maker in his workshop, the only supposed difference being that the master is a capitalist and the workman not. This way of distinguishing the master from the workman will apply, no doubt, to many businesses, but cannot be used in the same sense to mechanical engineering, which is the manufacturer of all manufacturing trades. The duty of the legitimate engineer is to design, create, and invent machinery of all kinds, while the duty of the workman, who goes by the same title, may now be said to consist, in a great measure, to feeding engineers' tools; and the more these tools are brought to perfection, the less will be the claim of the workman to be called engineer, for the machine will more than ever take the place of what I should call the engineer workman, and reduce his calling very much to that of a mere labourer, with very little physical work to do, and considerably less mental.

It is, therefore, I think high time the Institutions of Civil and Mechanical Engineers made this matter the subject of serious consideration. The engineering tribes want sifting, so that the public shall know when a civil engineer, a mechanical engineer, or an engineer workman is alluded to

in the columns of the press, and consequently no mistake made when we read of drunken and disorderly conduct, and sometimes very much worse, of engineers.

Then we have another element of confusion in the various institutions of engineering, such as the Institution of Civil Engineers, Institution of Mechanical Engineers, Society of Engineers, Society of Civil and Mechanical Engineers, and the Amalgamated Society of Engineers, making it perfectly bewildering to outsiders. How much better it would be if we had only the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Amalgamated Society of Engineers' Workmen, and perhaps one or two others—branches of the parent institutions—in large towns, such as Manchester, Liverpool, and Newcastle-on-Tyne, so that country members, their assistants, and pupils would have an opportunity of exchanging ideas.

Leaving out military engineers, I think we may reduce the engineering ranks to the civil engineer, mechanical engineer, and engineer workman; all other occupations now using the title of engineer, if deserving of it, will properly come under one of the above heads. This method of defining the engineering profession is the more important when we consider that these occupations have not the advantage of the legal and medical professions of having two or three of its members at least resident in every town and village in the kingdom. Only think what confusion is made in the minds of even otherwise intelligent people when gas-fitters, locomotive, stationary, and marine engine drivers, smiths, artesian well-sinkers, engine fitters, and even divers are allowed to style themselves engineers; and it is for this reason that real civil and mechanical engineers are looked upon in the majority of towns they are employed in with a certain degree of suspicion, and consequently do not take the social position they are entitled to. A great deal of good, I am convinced, might have been done in this matter if the engineering profession had been properly classified on the last census paper instead of being lumped between the shopkeepers and domestic servants, because then every intelligent person would have had it made clear to them.

Civil engineering should have come immediately after the medical profession, because its importance and the skill required to practise it places it before all other callings. It should have been required of civil engineers to state if they were members or associates of the Institution of Civil Engineers, or where they had been educated, or to whom articled.

Mechanical engineers should have headed the list of manufacturers, and required to state if a member of the Institution of Mechanical Engineers, &c., if a manufacturer of locomotive, marine, or stationary engines, and the number of men they employed. Under this head notice should have been given similar to that given on the census paper, that engine drivers, &c., were to be distinctly stated, that the word engineer alone was not to be used.

With unity of action, I do not think it would be a difficult thing for two such influential bodies as the Institutions of Civil and Mechanical Engineers, having so reasonable an object in view to obtain an Act of Parliament, vesting each with powers to decide either by examination or election the claim of all candidates to the title of engineer who have not been articled to civil or mechanical engineers, or are not at present in practice as civil or mechanical engineers.

I am, Sir, yours most obediently,

A Junior Assistant.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Market.—Yesterday there was a large attendance on 'Change at Middlesbrough. Pig iron was as much in request as it has been for several weeks past. No. 3 was eagerly inquired for, and in some cases 52s. a ton was offered for it. All the smelters keep booking fresh contracts and are sold forward very considerably. Shipments are active and the local demand is good.

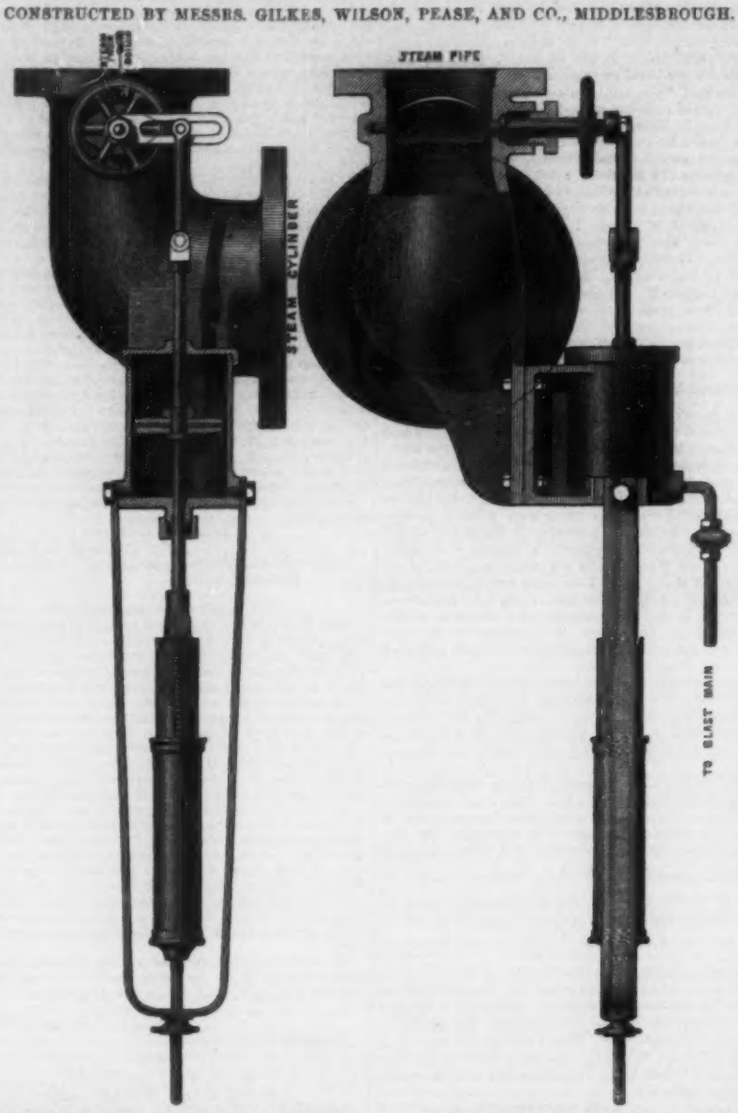
The Finished Iron Trade.—Every department of this growing trade is in a satisfactory condition. The finished iron works in the North of England use about one million tons of pig iron per annum. Rapid extensions are going on in various parts, and more new works on Tees-side are talked of. The rail trade continues remarkably good considering the time of year. Bar iron is in great request and the plate and angle iron trade could not be better. The foundries are very busy.

The Strike of Ironworkers at Middlesbrough.—As we anticipated last week the puddlers who struck at the Britannia Iron Works, Middlesbrough, for a better quality of iron were told by the operative Secretary of the Board of Arbitration that they had done wrong and they returned to work being satisfied to lay their complaint before the Board. This week the puddlers at the Stockton Rail Mill Company, Stockton, have given notice that if they do not obtain an advance of 6d. per ton on white iron they will leave in a fortnight. Like their neighbours at Middlesbrough, they are not justified in taking this step. Being members of the Board of Arbitration they ought to act in accordance with the regulations of that Board and lay the question before them. The masters are very much annoyed at the men in the face of Mr. Hughes's decision taking the matter of wages into their own hands instead of remaining true to the Board of Arbitration which settles all trade differences in an amicable manner. Unless the men generally adhere more strictly to the regulations of the Board of Arbitration it is feared that some of the masters will begin to agitate for some other method of settling disputes.

The Ouseburn Co-operative Engine Works, Newcastle-on-Tyne.—Since this establishment was opened on the co-operative system it has met with every success. The company have secured a large number of orders. The men work under the nine hours' system and the establishment is going on satisfactorily.

BLAST PRESSURE REGULATOR FOR BLOWING ENGINES.

CONSTRUCTED BY MESSRS. GILKES, WILSON, PEASE, AND CO., MIDDLESBROUGH.



The Nine Hours' Movement.—At last there is some indication that the disastrous struggle between capital and labour in the engineering trade at Newcastle respecting the nine hours' movement will soon be ended. Lately the question has been discussed in the *Times*, and Sir William Armstrong has written proposing that as the men wished a reduction of five hours a week the masters should concede two hours and pay the men extra for working the other three hours. In reply to this the president of the League, Mr. Burnett, has written to the *Times* suggesting that after accepting the two hours the men should ask for the other three hours, but be willing to accept a proportionate reduction in their wages equivalent to the number of hours granted. This proposition looks as if there was really some chance of the matter being settled. Neither masters nor men show any signs of weakness. The masters are firm and the men continue to show a bold front. This week the strike hands have received 11s. each from the League, and there is a large balance in hand. The number of men on strike remaining in Newcastle has been reduced to 1968. All the chief towns in the United Kingdom continue to subscribe liberally to the Newcastle men. Batches of foreigners are leaving the works and returning to Rotterdam, Hamburg, and Brussels. It is to be hoped that the end is not far off.

Shipbuilding.—On the Tyne, Wear, Tees, and Humber all the shipbuilders are as busy as possible. On the latter river Messrs. Earle's shipyard is to be handed over to a limited liability company, of which Mr. Reed, the late chief constructor of the navy, is to be one of the managing directors.

Engineering.—The pressure for marine engines is still very heavy. Engineering generally is remarkably brisk.

The Mines.—All the ironstone mines throughout Cleveland are working satisfactorily. In South Durham the collieries are turning out as much coal as they possibly can, and the coke ovens are kept fully occupied to meet the heavy requirements of the blast furnaces.

BLAST PRESSURE REGULATOR.

The above engravings show a handy arrangement for regulating the pressure of blast supplied by blowing engines, which has been adopted by Messrs. Gilkes, Wilson, and Co., of the Tees Iron Works, Middlesbrough. As all blast furnace managers well know, it is important to keep the supply of blast at a steady pressure, and the want of this regularity suggested to the firm just named the idea of regulating the pressure by the action of the blast itself, the result being the construction of the instrument we illustrate. The apparatus consists of a small blast cylinder, the piston of which is acted upon by the pressure of the blast, while the piston rod is carried upwards and downwards, being connected at its upper end to a lever on the spindle of the throttle valve by which the supply of steam to the blowing engine is governed, while at the lower end it is attached to a spring balance, as shown. This balance is graduated accordi g to the area of the cylinder and the pressure of the blast; and it will be seen that any increase in the blast pressure will cause the piston to rise and partly shut off the steam from the blowing engine; while, if the pressure falls, the contrary action will take place. If a higher or lower blast pressure should be required, it is only necessary to adjust the end at the bottom of the spring balance until the scale shows the desired pressure. The whole apparatus—which we should mention has been designed by Mr. Charles Wood, the engineer of the Tees Iron Works—is very simple and effective.

Canadian Public Works.—The Canadian Public Works Department has called for tenders for the completion of the work on the tower of the Parliament buildings at Ottawa. The work is to be commenced next spring. The contractor for the Parliament library building is proceeding satisfactorily with his operations.

BESSEMER'S APPARATUS FOR FIRING HEAVY ORDNANCE.

FIG. 1.

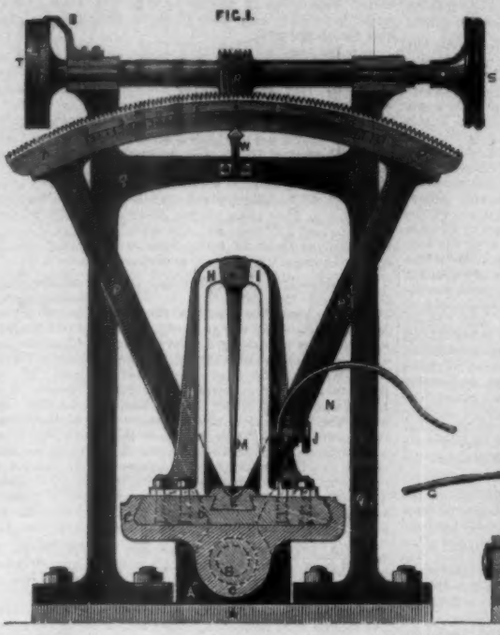
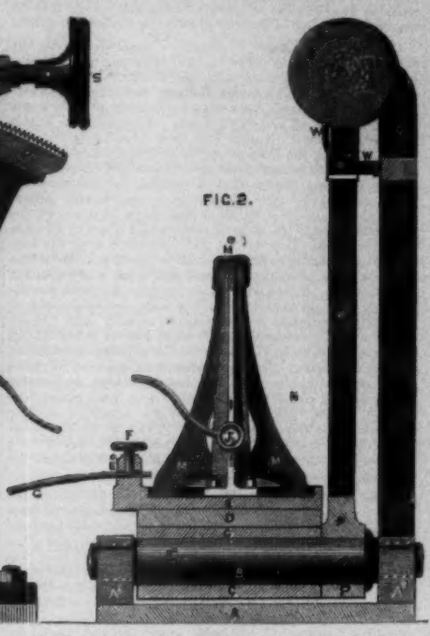


FIG. 2.



A FORTNIGHT since* we described and illustrated the principles which Mr. Bessemer has embodied in the enormously heavy ordnance with which he is at present experimenting, and endeavouring to develop to perfection. To-day we propose to refer to a highly ingenious apparatus connected with the subject, and which he has designed for the purpose of discharging this monstrous marine artillery, which is obviously too massive to be trained and fired by any ordinary method. The apparatus, which is shown in the drawing, is attached to the gun or carriage, and it is provided with a small weighted tumbler or pendulum, supported on a knife edge, and having its heavier end upwards. This tumbler is placed between supports, against one of which its heavier end rests. The distance between the supports is so small as to admit only of a very slight movement of the tumbler between them, so that whenever it passes from an inclined to a vertical position, it is thrown over and into contact with the other support by the smallest alteration in the elevation of the gun, and in so doing it establishes metallic contact, and discharges the gun by means of the ignition of a fuse by electricity.

Means are provided for varying and indicating at pleasure the inclination of the gun to the tumbler. A second break in the communication between the battery and the charge is also made, so that the rolling of the vessel may cause the gun to pass and repass the angle of elevation at which it is to be fired, for any length of time after it is loaded, and to make or break contact in its upward and downward movement without igniting the charge until the gunner makes contact at the second break, which is under his control; when this is done, so soon as the gun rises up to the firing angle, the tumbler falls over, and completes the circuit necessary to fire the charge.

The instrument is provided with a graduated screw, by turning the milled head of which the angle in relation to the axis of the gun at which the tumbler becomes vertical, is altered at will to the angle of elevation at which it is desired to fire the gun. In the engravings, Fig. 1 is a sectional elevation of the apparatus, and Fig. 2 is a vertical section, with some parts shown in elevation. On the base-plate, A, are two plummer blocks, A*, which support the axis, B, upon which a brass frame, C, is secured by the cotter, B*. The frame, C, has a dovetailed channel extending throughout its whole length, and into it is fitted a piece of non-conducting material, as shown at D. On the upper side of D, a piece of brass, E, is placed into a dovetailed groove, as shown, extending at one end beyond the non-conducting material, where it is formed into a cylindrical shape, as shown at E*, with a mill-headed screw, F, placed in it for the purpose of securing the conducting wire, G, in a hole passing through E, and thus insuring a metallic communication between the wire and the insulated piece, E. Two standards, H and I, are screwed to the insulating material, and are at intervals out of metallic contact with the other parts of the apparatus. The support, I, has a boss, I*, formed upon it, with a second mill-headed screw, J, for the purpose of securing the conducting wire, K, in the hole passing through the boss, I*. The inverted pendulum, M, is placed between the standards, H and I, its lower or knife edge resting on a V-shaped groove formed on the upper side of the insulated piece of brass, E, with which, of course, it is at all times in metallic contact. Now, whenever the upper or heavier part, M*, of the tumbler, M, is in contact with the upper end of the standard, I, communication will be established between the wire, G, and the wire, K, and a current of electricity may then be conveyed from a battery in connexion with the wire, G, to the charge in the gun. But so long as the position of the apparatus is such that the tumbler rests against H, the communication between the wires, G and K, is cut off, until the motion of the vessel throws the tumbler over on to the other support.

In order to fix definitely the angle of discharge, a segment, P, is attached to the axis, B, so that any motion of this segment on its axis causes a corresponding motion of the insulating material, D, and the supports, H and I. To the base plate, A, is secured a frame, Q, carrying at its upper end a dividing screw, R, turning round the axis, R*. This axis is provided with a thumb-screw, S, and at the opposite end is a dividing wheel, T, with thirty divisions marked upon it, and provided with an index, U, for marking the exact distance through which it is moved.

The outer edge of the segment, P, is cut into teeth gearing into the dividing screw, R, the pitch of which is such that it moves the segment one-half of a degree for each complete revolution of itself. On the face of the segment, P, is a graduated scale indicating degrees and half degrees, figured right and left from a central zero point indicating no elevation or depression. An index, W, projects from the frame, Q, to point out the elevation in degrees and half degrees, while the wheel, T, divides each half degree into thirty parts, so that the angle of elevation in degrees and minutes can be ascertained.

Thus, if the base plate, A, be placed in a horizontal plane, and the chase of the gun be also in the same horizontal plane, and it is desired to fire the gun with an elevation of 3 deg. 7 minutes, it will be necessary to move round S, until the index, W, is opposite the line numbered 3 on the scale, and the finger, U, is at 7 on the wheel, T. When thus adjusted, so soon as the gun by the oscillation of the vessel reaches the elevation of 3 deg. 7 minutes, the tumbler, M, will fall over and complete the necessary contact, and the gun will be discharged. So long, however, as the wire, G, is kept out of contact with the battery, the gun may pass to and fro through the exact angle without explosion, but when the contact is made, the charge is fired the instant that the gun by means of the rolling of the ship rises up or falls down to the assigned inclination.

To attain an extreme accuracy of fire allowance must be made for two things, the time occupied by the tumbler in falling through the short distance upon the support, and the time the projectile requires to traverse the gun, a more important matter in ordnance of such great length as Mr. Bessemer proposes to employ.

It is obvious that such an apparatus as we have described may be made available for firing ordinary heavy guns at sea, but it is especially adopted for the Bessemer ordnance, which would require from its length and weight to form absolutely a part of the vessel in which it was placed and which would form simply a floating gun carriage. Such ordnance it would be manifestly impossible to elevate or depress in the usual manner.

* See ENGINEERING, page 173.

SHOEBURYNESS EXPERIMENTS.

LAST Tuesday witnessed another of those gatherings of military and naval officers at Shoeburyness which occasionally occur, and which contribute to the relief of a considerable amount of monotony that exists in those parts. Upon the occasion to which we refer the artillery experimental grounds were visited by a large number of distinguished foreign officers, who have attended the recent military manœuvres in Hampshire. No new feature, however, was presented in the programme, which included the firing of field guns against rows of targets representing columns of troops, and of heavy guns against the armour-plated targets. Some shots were also fired from the 25-ton gun against a floating target, as well as from the 7-in. Armstrong breech-loader, mounted on a Moncrieff carriage. Some 24-pounder Hales's rockets and a few life-saving rockets were then fired, the proceedings concluding with a 600 lb. shell fired at 200 yards against a wood target 9 in. thick. Of course a big hole was knocked through the timbers, but we fail to see the value of this experiment, even to strangers, unless it was to show the action of the Pettman general service percussion fuze used with this shell. As already observed, no novelties were presented on the occasion; in fact, the object was to show our foreign friends the present condition of our defensive material. One noteworthy incident however occurred, and that was the penetration of the 18-in. iron target by the 10-in. gun, firing the recently improved Palliser 400-lb. projectiles with an increased charge of 70 lb. of pebble powder. This target, it will be remembered, consists of a face-plate 8 in. thick backed with 6 in. of teak, behind which is a 5-in. plate, with another 6 in. of teak beyond it, and a 1½-in. iron skin plating in the rear. The penetration was very complete, and gave rise to no little astonishment, especially as the plate stood the shot remarkably well, neither crack nor fissure occurring. It is, however, to be borne in mind that it is by no means unusual to find that of several shots fired under precisely similar conditions at the same target, some will effect penetration, whilst others will fail in so doing. Hence, although the 10-in. gun may appear to have done wonders, it may be after all that it has only done its own proper work, the penetration of the shot having been assisted by some local weakness in the plate at the point of impact. One thing, however, is quite certain—and these repeated penetrations only the more strongly confirm our opinion in the matter—and that is, that our present system of backing is defective. With the results of the firing against the old Millwall shield still fresh in memory, we must repeat that we have retrograded rather than advanced in our defensive practice since 1868.

FOREIGN AND COLONIAL NOTES.

Floods in India.—Simla has been completely isolated by great floods. No less than 60 miles of the East Indian Railway above Saharunpore were also flood in the course of August. Some portions of the line were even washed away.

Taranaki (N.Z.) Steel Sand.—Taranaki steel sand has been again under trial, and this time under the auspices of the general government of New Zealand. Experiments are being made which are expected to show, *inter alia*, why former attempts to turn the sand to account have failed, and how they should be carried on in order to prove commercially successful.

Prince Edward Island.—The Ocean Steamship Company, which has been formed in Prince Edward Island with a view to the establishment of steamship communication between Charlottetown and Liverpool, has made arrangements in accordance with which a first-class steamer, now being built by Messrs. Napier and Sons, of Glasgow, will be ready to take in cargo by March 25, 1872. Should these arrangements be successfully carried out, the vessel will leave Liverpool on her first voyage early in April, 1872.

Labuan Coal.—Labuan coal has been highly spoken of by Mr. Duncan of the Peninsula and Oriental Steam Navigation Company's ship China. Mr. Duncan has reported to his directors as follows: "Singapore, March 14. The result of our experiments with the Labuan coal proved highly satisfactory in every way, working the fires, consumption, and amount of work performed. Compared with English Newcastle coal, we obtained the same rate of speed at the same rate of consumption. Compared with Lancashire and North Wales coal, we obtained a higher rate of speed (half a knot) at the same rate of consumption. Compared with South Wales coal, to obtain the same rate of speed (that is, eight knots) we used 10 per cent. less, and by mixing in equal quantities with the small South Wales coal we maintained the eight knot speed. We then used the small South Wales coal by itself and only obtained a speed of six knots. The engineers in charge of each watch and also their firemen speak in the highest terms of the Labuan coal."

Scutari and Ismidt Railway.—The works of this line are making good progress, and the approaches to the Haidar Pasha *scala*, near which the Scutari terminus of the line will be constructed, are being improved. As soon as the rails are laid to Ismidt, the Turkish Government will, it is said, execute the rough earthworks of an extension to Angora.

Punjab Railway.—This line has been very greatly damaged by floods. As we have recently stated, the bridge which carries the line over the Beas has been broken. One pile has sunk carrying with it the girders on each side of it. The defence wall built to protect the junction of the bridge with the ordinary embankment has also been broken down. There is, therefore, a serious break in traffic between the Beas and

Kurtapore, a river to cross and 9 miles of road to travel. From Kurtapore to Phillour on the banks of the Sutledge the pressure of water has not been so great. But at the Sutledge the bridge is considered doubtful, and no trains are permitted to pass over it. The embankment on the eastern side of the Sutledge has also been damaged.

Carl Pihl in Canada.—Mr. Carl Pihl has recently returned from his visit to Canada, where he was present at the opening of the Toronto, Grey, and Bruce Railway.

Western Extension Railway of New Brunswick.—This line has been opened as between St. John and Bangor. Appropriate festivities took place on the occasion.

Lake Tahoe Tunnel.—Colonel von Schmidt has returned to San Francisco from his camp on the Truckee, and has reported progress as to his task of introducing the waters of Lake Tahoe to the valley of the Sacramento and the cities of the Pacific slope. The entrances to and the mouth of the tunnel having been fixed upon, arrangements for the immediate commencement of the work have been completed.

Canadian Railway Amalgamation.—At a joint meeting of the Boards of the London, Huron, and Bruce, and the Toronto, Grey, and Bruce Railway Companies held at Toronto, an amalgamation of the lines from Wingham northwards was decided upon. It was arranged that there should be a joint delegation of six from each Board. The route of an extension of the Toronto line which is to be carried out is to be from Mount Forest through Harriston, and Lisadel, Gorrie, &c.

Commerce of Philadelphia.—The value of the exports from the port of Philadelphia in August was 2,172,643 dols., against 1,629,936 dols. in August, 1870, showing an increase of 542,409 dols. The heaviest item of export during the month was petroleum, which figured for 1,468,169 dols.

Railways in South Australia.—Plans and estimates for a railway extending 200 miles northwards from Port Augusta have been prepared by the colonial engineer of South Australia. The Colonial Government has not yet, however, arrived at any decision as to the course which it will take upon the question. The estimates as to the cost of the work are stated to be somewhat heavier than was at first anticipated.

Rolling Stock in Belgium.—For a long time past there have been great complaints as to the scarcity of rolling stock upon the Belgian State Railways. The Belgian Minister of Public Works has at last yielded to the clamour and has agreed to place upon the system 1020 more coal trucks and 204 more rail trucks. It was at first proposed to order only 420 additional coal trucks, but in the course of last week the number was carried to 1020. Contracts for the new plant were let on Wednesday.

Salem Creek.—Salem Creek, New Jersey, reaches the Delaware river by a very circuitous route and many attempts have been made within the last 70 years to dig a canal which would relieve the lowlands of Salem county from the overplus of water, and open a comparatively short navigable channel to the Delaware. Recently the enterprise has been again resumed and a sufficient sum is stated to have been contributed to insure the success of the project. The canal is to extend from the Delaware to Halsey's Bridge, eight or ten miles above Salem by the circuitous route of the creek.

Public Works at Lyttelton (N.Z.).—The materials required for the Lyttelton breakwater and viaduct have arrived on the site of the works, which have in consequence been proceeded with. The works, when completed, will prove a great boon to the shipping trade of the port. The completion of a new railway wharf had been delayed, owing to the timber required not being available. A turntable and line of rails for shunting purposes had been fixed.

Ottawa Water Works.—Mr. Leonge, C.E., of Montreal, has been visiting Ottawa. He has been invited to prepare a report on the city water works.

Belgian Mechanical Industry.—The Belgian Railways Working Company has obtained an order for 200 additional coal trucks which are about to be placed upon the Sarrebruck Royal Railway. The Marcinelle Metallurgical Company has constructed a blast furnace upon a new model. The Liege and Maestricht Railway Company is about to increase its rolling stock by the acquisition of 50 new coal wagons to carry 10 tons each.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—There has not been any serious or extensive fluctuation in the price of Scotch pig iron, but the general tendency has been downwards. This day week the market closed at 60s. 9d. for sellers, with buyers a shade higher; on Friday 61s. fourteen days was paid, but there was a decline towards the close; and on Monday a large business was done at 60s. 3d. to 60s. 5d. cash, and 60s. 6d. to 60s. 6d. one month. Yesterday's prices varied between 60s. and 59s. 9d. cash, and 60s. 3d. to 60s. one month, the lower rates being the nominal quotations at the close. To-day's market has been easier—59s. 10½d. to 59s. 8d. one month, and 59s. 6d. to 59s. 4d. cash was taken, closing buyers at 59s. 6d. The iron trade generally is exceedingly healthy, but the warrant market does not seem to sympathise with it. The local demand continues to be exceedingly good, and the demand from the United States and the Continent is in every sense satisfactory. There is very little iron in the hands of the Scotch ironmasters; all that they can make is to order. Shipments continue to be large. Last week they were—Foreign, 11,096 tons; coastwise, 5677 tons; total, 16,173 tons; same week last year, 14,850 tons. Total increase for the year, 146,087 tons. The anomalous state of the warrant market is exciting a good deal of attention. On the 24th August, when the shipments were about 126,000 tons over those of last year at the same time, the selling price of G. M. B. iron was 63s. 6d. per ton; and on the 28th of July, with an increase of only 90,000 tons in the shipments the price stood at 60s. 6d., the same price as has been paid within the last few days, although the shipments have increased to 146,000 tons. Thus the increase of 56,000 in the shipments during the last two months counts for nothing in the way of affecting the market prices.

Caledonian Railway Employés' Wages.—On Saturday night a large meeting of the mineral engine drivers, firemen, and brakesmen connected with the Motherwell locomotive department of the Caledonian Railway, was held at Motherwell for the purpose of conferring in reference to their wages and the length of the day's work. It was stated that a deputation of their number had been courteously received by Mr. Britton, the manager of the department, and that he had promised to present their petition to the directors. It having been announced that a meeting of the directors would not be held until the 3rd prox., considerable discussion followed, during which it was stated by some of the speakers that in all likelihood the men would obtain an advance of wages on the present rates, and by others that the men should be united and firm in their request as to the adoption of the ten hours' system, and the doing away with the "trip" hours. The chairman and others, however, recommended patience on the part of the men; and in accordance with this suggestion, it was resolved to wait until the decision of the directors should be made known before taking any further action in the matter. The pointsmen employed by the Caledonian Railway Company in the west of Scotland, are also making arrangements for asking an increase of wages and overtime. The wages now paid range from 14s. to 16s. per week, and at the more important stations 18s. for seven days when necessary, and no pay for overtime. It is proposed by the men that there should be a general rise of 2s. per week, and that all above 60 hours per week should be paid as overtime.

A New Inman Liner.—The largest steamer yet built on the Clyde for the mercantile marine was launched last week from the yard of Messrs. Tod and McGregor, by whom she has been built for the Inman, or, Liverpool, Philadelphia, and New York Company's Royal Mail line of steamers. She was named the City of Montreal. The dimensions of the vessel are as follows:—Length from taffrail to back of figure, 453 ft.; beam, moulded, 45 ft.; depth, moulded, 36 ft.; tonnage, B.M., 3800 tons; tonnage, gross register, 4600 tons. The engines for this vessel, 600 horse power nominal, have been constructed by the builders at their Clyde Foundry. Messrs. Tod and McGregor are about to commence the building of a still larger vessel for the same company. She will be named the City of Richmond, and will have a register tonnage of 4800 tons

Dunfermline Water Supply.—A new, or rather an old scheme is now exciting attention at Dunfermline, the object of which is to bring an additional water supply from the river Devon, and a petition is now in course of being signed for presentation to the Town Council in its favour. The distance the water will require to be brought is calculated to be between 14 and 15 miles, and it is estimated that 50 gallons per head, for 20,000 inhabitants, can be brought this distance at a cost of 20,000*l.* To supply the burgh of Inverkeithing, as also the villages of Limekilns and Charlestown, an estimate of 3000*l.* additional is mentioned. The inhabitants of these places have agreed to take the Devon water should Dunfermline adopt the scheme. The only drawback to the scheme is the debt contracted by the police commission; but a town with an annual revenue of 30000*l.*, and where the inhabitants require to pay no police assessment is surely able to give its inhabitants clean water.

Anderson's University.—The quarterly meeting of the trustees of this institution was held last week, Mr. James Young, of Kelly, president, in the chair. In respect of the natural philosophy chair lately vacated by the election of Mr. A. S. Herschel to the College of Physical Science, Newcastle-on-Tyne, it was resolved to defer making a permanent appointment till next year, in the hope that some scheme of endowment may then be completed for the vacant chair in conjunction with the proposed chair of applied physics. In the meantime an interim appointment has been made for the ensuing winter session. Mr. James Dewar, F.R.S.E., F.C.S., Professor of Chemistry in the Royal Veterinary College, Edinburgh, will be the interim professor.

The Young Chair of Technical Chemistry.—Professor Gustav Bischof, of Bonn, the gentleman who has been appointed to this chair, has arrived in Glasgow, and is engaged in making extensive preparations for equipping the laboratory in the most complete manner. His course of lectures and laboratory instruction will commence at the end of October. No students will be admitted to the laboratory who have not previously acquired a knowledge of the theory of chemistry and of the principles and methods of qualitative analysis. There will be some ten or twelve bursaries of scholarships of 50*l.* a year to start with.

NOTES FROM THE SOUTH-WEST.

Monmouthshire Railway.—During the past half year two locomotive engines have been purchased by the Monmouthshire Railway Company, and have been charged to capital. One locomotive has also been built at the company's workshops and has been charged to revenue. One composite carriage to meet the increasing traffic of the line has been built at the company's workshops and has been charged to capital. Six covered goods wagons and two timber trucks have been built and charged to revenue to replace a similar number unfit for further use. The converting of the existing single line between Aberbeeg and Abertillery into a double line is being proceeded with as rapidly as possible, and will be completed before the end of the year.

State of Trade at Merthyr.—The coal trade of the Merthyr district is regaining a satisfactory tone. The men are working well in the Aberdare Valley. There are, however, symptoms of discontent in other quarters. The iron trade is in a tolerably satisfactory state.

The Late Strike in South Wales.—The late strike among the steam coal colliers of South Wales lasted twelve weeks. The amount received during that period from the Amalgamated Association of Miners by each man engaged in the strike is stated to have been 1*l.* 5s. 7d. altogether, or a little over 2s. 1d. per week.

New Tin Works.—It is said to be the intention of some capitalists in the neighbourhood of Swansea to construct new tin works. The works will be erected at Penclawdd and Llanrhidian.

Sewage at Merthyr.—As was recently stated, the Merthyr Board of Health has established some filtering areas to effect the purification of the sewage hitherto polluting the river Taff by the use of a small number of acres as intermittent filtering beds. The areas are situated near Treedyrhiew, and the extent of the land devoted to them is 20 acres, which are divided into four areas of five acres each. The whole is drained about 7 ft. deep, and the daily discharge of sewage, amounting to about 600,000 gallons, is passed through that depth of natural soil before it is discharged.

The Severn Tunnel.—At the last meeting of the Cardiff Chamber of Commerce, Mr. C. Richardson, engineer, of Bristol, explained the nature of the Severn Tunnel scheme. Mr. Richardson said one great object which it was sought to accomplish by tunnelling the Severn near the New Passage, was to establish an unbroken railway communication between South Wales and the west and south of England. He proposed to construct a railway from Pilning Station on the Bristol and South Wales Union line, and by tunnelling under the Severn at a short distance west of the present steam ferry at New Passage, to join the South Wales Railway at Roggiett, near Portskewett. The Severn would be crossed at a favourable point, on account of the remarkable nature of the soil, which would greatly facilitate the work. The estimated cost of the tunnel was 535,560*l.*, while the estimated cost of the whole scheme would be 750,000*l.* The tunnel would probably take about five years to construct.

Welsh Shipping Movements.—The Robert Wendt has cleared from Cardiff for Baltimore with 548 tons of railway iron supplied by Messrs. Guest and Co. The William Yeo has cleared from Newport for Stonington with 950 tons of iron supplied by the Tredegar Iron Company. The St. James has cleared from Cardiff for Mobile with 1000 tons of railway iron supplied by the Aberdare Iron Company. The Said, screw steamer, has cleared from Newport for Vera Cruz with 1050 tons of iron supplied by the Ebbw Vale Company. The Marbella, screw steamer, has cleared from Cardiff for Barcelona with 900 tons of railway iron and 70 tons of coke supplied by the Rhymney Iron Company. The Millina has cleared from Cardiff for St. Petersburg with a large steam hammer. The Thomas Daniel has cleared from Cardiff for Talcahuano with 406 tons of railway iron and 38 tons of galvanised iron supplied by the Rhymney Iron Company. The Nereid has cleared from Cardiff for Rotterdam with 325 tons of railway iron supplied by the Aberdare Iron Company. The Rosslare has cleared from Newport for Annapolis (Nova Scotia) with 500 tons of iron supplied by the Tredegar Iron Company. The Victoire has cleared from Newport for Vera Cruz with 574 tons of iron supplied by Messrs. Batchelor and Co. The J. B. Bell has cleared from Newport for New York with 1100 tons of iron supplied by the Blaenavon Iron Company.

Carmarthenshire Railway.—A meeting has been held at Llanelly to consider the question of a proposed Carmarthenshire mineral railway. The meeting resolved to support the scheme on condition that the Cross Hands to Llanelly route should be substituted for that to Pontardulais.

State of Trade at Newport.—At the last South Wales and West of England coal and metal market at Newport, a moderate amount of business was transacted. Middlesbrough pig was firm at 57s. for No. 4 ex-ship South Wales ports. Hematite was still in good demand, 85s. was asked for No. 3. Some large sales were reported of Yorkshire brands. Hematite ores, especially those from the Cumberland and Lancashire mines, continued to sell at good price. The reports received from the iron works of the Newport district were satisfactory, some large orders for rails having recently been given out.

East Somerset Railway.—The directors of this railway report a small decrease in the traffic during the past half year. The diminution is attributed to a portion of the traffic having been diverted from the Wells station to the Cheddar Valley line.

State of Trade at Swansea.—There is little speculation in the iron trade in the Swansea district and stocks in makers' hands are small. Mr. Talbot's furnaces near Tondu are expected to be shortly put in blast by an eminent firm of Swansea merchants. Some fine samples of magnetic ore from Sweden have been recently received in the district, and they have attracted some attention.

THE ROLLING OF GUNBOATS.—The gunboats Bustard and Kite (of the Blazer class), in charge of Captain Charles Fellowes and Staff of the steam reserve, were taken into the offing at Plymouth on Friday, in order to test their rolling motion in a sea way, and discover whether it is easier with the 18-ton gun in its position on the platform level with the fore deck, or when it is lowered into the well beneath; and, although the weather was not sufficiently rough to subject the vessels to a severe test, yet the result showed that they are much steadier when the gun is up in its position than when it is below. The wind was N.W., force 2, with a moderate sea. The Bustard, with her gun on deck, made only 11 rolls per minute, and the greatest roll was from 7° to port (leeward) to 4° to starboard (windward), but with the gun below she made 14 rolls per minute, the greatest roll being from 9° to port to 13° to starboard, being 3 rolls per minute more with just twice the amount of heel. A similar result was obtained with the Kite.

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NOTICE OF MEETING.

SOCIETY OF ENGINEERS.—On Monday, the 2nd October, 1871, at 7.30 P.M., a paper will be read on "Recent Improvements in Explosive Compounds," by Mr. Perry F. Nursey.

THE "ENGINEERING" DIRECTORY is published this week on the thirteenth page of our advertisement sheet.

NOTICE TO AMERICAN SUBSCRIBERS.

In consequence of the great increase in our American connexion, we have found it necessary to establish a branch office in the United States. Communications may in future be addressed to MR. GEORGE EDWARD HARDING, C.E., *of* 176, *Broadway, New York, who is our accredited representative.*

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of* 1*l.* 14*s.* 8*d.* ($8.32, *gold*) *per annum, payable in advance.*

CONTENTS.

	PAGE		PAGE
Bauschinger's Indicator Experiments on Locomotives	199	Foreign and Colonial Notes	205
Variable Expansion Gear	201	Notes from the South-West	206
Compound Marine Engines	203	Notes from the North	206
The Rights of Inventors	203	Engineers in India	207
Railway Gauges	203	Property in Invention	207
Macnay's Permanent Way	203	Institution of Civil Engineers	208
Definition of Engineers	203	London to Bombay Direct	209
Notes from Cleveland and the Northern Counties	204	Opening of the Mont Cenis Tunnel	209
Rhodes' Pressure Regulator for Blowing Engines	204	The Oxy-hydric Light	210
Bessemer's Apparatus for Firing Heavy Ordnance	205	Literature	210
Shoeburyness Experiments	205	Explosive Compounds	210
		Notes from Paris	211
		Recent Patents	212
		Soluble Mortar	213
		Registering Weighing Machine	213

ENGINEERING.

FRIDAY, SEPTEMBER 29, 1871.

PROPERTY IN INVENTION.

THE advocates of free trade in invention may be divided into two classes—those of extreme opinions who practically seek to sweep down all barriers of protection, and those of more moderate views who acknowledge that invention has some rights which should be respected within narrow limits. Between these two parties there is a wide interval of opinion—the one respects no privileges, the other makes them a question of degree. Yet both are compelled by the mere force of facts to admit that under certain circumstances their theories reduced to practice would be faulty, and consequently they seek to avoid, by expedients more or less pitiful, the evasion of the difficulties into which any grand discovery or profound invention would plunge them.

Thus Mr. Macfie, who would deal with all ordinary cases by a stock of ribbon and a stamping press, has to make provision for exceptional inventions, such as those of Mr. Bessemer; and M. Schneider who, under some circumstances, believes in and respects invention, would seek to place such obstacles in the way of its progress as would in reality deprive most inventors of all privileges. But the very exceptions over which opponents to protection stumble, proves the weakness of the cause they advocate. Great or small, an invention is an invention, and if one achieves the revolution of a nation's industry, while another only modifies the form of a needle, it is idle to say that similar privileges in a just degree shall not be secured to the latter, if the former is protected. Unless this be done it is obvious that a vast injustice would be wrought upon the mass of inventors—the army of privates of the Patent Office. We do not speak here of the long list of persons to whom useless, frivolous, and vexatious protections are yearly granted, to the disgrace of the Patent Law organization, and the needless annoyance and trouble of worthy patentees; but of those inventors who labour meritoriously and usefully according to their abilities for their own benefit and for that of the public.

Modification of the Patent Law, and reform in its administration, are of course subjects totally apart and distinct from the question of property in invention; the former is merely the instrument for securing the latter, and if that instrument require reconstruction, as undoubtedly it does—for at present it operates in a manner which satisfies no one—the alteration in its details, the cessation of its abuses, and the extension and perfection of its favourable points, should form the subject of much careful consideration and able legislation. But in the meantime we are threatened with a revolution which shall render the Patent Office, with all its good and evil, useless; because if the co-operation against inventors should succeed, patent right would be swept away. True, this contingency is remote, and the chances of its success very small; while the probability is great, that if it succeeded, and legislation abolished the rights of inventors, the force of public opinion would speedily be exerted to re-establish those rights which are clearly undeniable. To argue, therefore, against arguments which, if their mischievous tendencies met with temporary success, would raise only an irresistible demonstration on behalf of patent right, may seem somewhat idle, but there are those who—unprejudiced and capable of forming responsible opinions (we do not include Mr. Macfie)—hold that there is no real property in invention, that the special combination of special forms of material common to all, which form the subject of almost all patents, should not give to the one who designs and combines those forms an absolute right over them for a term of years. These adopt M. Schneider's argument that similar occupations, shared in common by a multitude, conduce to similar trains of thought, and consequently to similar results; so that in nearly all cases the progress of industry would almost spontaneously develop what is called invention, and these developments would become naturally public property, and not private monopoly. Arguing thus, it is maintained that works of art and literature, the pure embodiments of the mind, have nothing in common with those mental efforts, which are helped by circumstances to take useful shape, and that the latter have no right to share the protection which no one seeks to deny to the former. But it is forgotten that a large number of inventors are—too frequently, to their misfortune—to the manner born, just as are great authors, musicians, painters, sculptors, and that while they equally, with other artists, derive inspiration from what exists, they are not led on by easy stages by the help of others to arrive at a point easily and naturally within reach.

Of course a number of patentees are helped by circumstances, and, possessing perception and faculty for improvement, are led on a step beyond their fellows to a possible success; while others, starting from the platform of some special subject they have made their own, add improvements, modifications, and extensions, all of which have for their object the increased usefulness of their speciality.

But, however attained, invention is one thing, the introduction of it to public service is another; and this point is one apparently entirely overlooked by those silly philosophers who would reward applied inventions with medals, or with royal acknowledgment.

Even to those not wanting in means, not lacking in power, the introduction of an invention is, for the most part, a weary and thankless task. How much money has to be expended, how many years of hard labour have to be devoted to the work thousands of inventors can bear witness. And it is this capital invested, both in time and money, that gives beyond all else an indisputable property in invention. If we listen to Mr. Macfie, who talks upon the subject exactly as Mr. Harold Skimpole might have talked, we would believe that inventions are simply flowers, springing up of themselves in the fields of industry (which, being tilled and enriched by all, are the property of all), that no one man has a right to gather. But it is not so; the seeds may be gathered from the common stock, but they must be carefully planted in the right soil, nurtured with unceasing care, directed in their growth with unwearying skill, and the watchfulness and labour of years must be devoted to their development before the uncertain reward can be obtained.

The inventor, as a rule, makes himself the slave of a losing hazard, and, at the best, he can but look forward as a return for his inevitable labours, to an uncertain ownership of a brief reversion, the gainer of a passing inheritance which has to become, within a few years at most, the property of the public.

And if this be the case with those who are passably favoured with friends and means, how much harder is the task for the poor patentee who struggles through infinite difficulties to introduce his invention, now and then attaining success, generally unmitigated disaster.

If we would obtain an illustration of the working of free trade in patents, we may in some degree do so by turning to the old story of Government and inventors. Over and over again we may hear the same tale of neglect, delay, indifference, absorption, sometimes appropriation, and injustice; and what is now the exception amongst inventors (for few, unless they are sure of patronage, are foolish enough to seek it from the Government) would be the rule if protection were swept away, and communism rendered possible. For it must be remembered that inventions are not born mature; their growth is a slow and costly process, and exactly the same amount of labour and expense would be incurred in developing every useful invention were it public property, as is now required; and though that labour and expense would probably not be concentrated and individualised as it is now, the great incitement to originate would be gone, and such inventions as were made public, would necessarily gravitate to those few who could best use them for their own profit, whilst none would originate except those who are inventors in spite of themselves.

A good deal of high-flown sentiment has been scattered touching the natural rights of invention, by those who taking a high moral ground seek to argue that it is a "sacred heritage," the violation of which is an outrage not only of equity but of religion. Besides being unpractical, this is to say the least ridiculous; none but those, if there be any such who make abstract inventions unassisted by the previous labours of others, have any business to talk about a "sacred heritage," and for their own interests the less these say about it the better.

But policy and justice point decisively towards awarding to those who labour usefully in any cause the full value of their work, whatever it may be; the observance of this principle forms the very framework of society. Whether, therefore, energy and capital be devoted to the establishment of a common industry, or to the development of a special invention, it is clear that both should, if they are of service, meet with their just return, and that the latter should not sustain the indignity of a reward, but receive the fair payment due to labour.

Viewed from all points, the rights of property in invention are too strong to be shaken by the most earnest efforts of honest or dishonest antagonists, who are doing, however, real service to the cause they oppose by encouraging free discussion on the subject, and of opening the way to the investigation of the evils and abuses which exist in the constitution and administration of the Patent Law.

ENGINEERS IN INDIA.

THE question of the position of civil engineers in India is one which has admittedly been for some time past under the consideration of the Indian Government, whilst its satisfactory solution appears to be as far off as ever. Under the depressing influence of hope deferred, it is not surprising that the just complaints of Government engineers in India should find a place in the pages of ENGINEERING as the chief representative paper of the profession. Such being the case, and an appeal being thus indirectly made to this journal for such support of their claims before the public, as upon mature and unbiassed consideration may seem to be just and fair, it would not become us to abstain from an impartial consideration of those claims, notwithstanding that the self-imposed position thereby implied of placing oneself between employer and employed is at no time an enviable one. The grievances of civil engineers in India have a four-

fold character, and they refer to their salaries, position, leave rules, and pension regulations, in all of which they are placed at a very considerable disadvantage when compared with officers in similar positions as regards pay and responsibilities in other branches of the Administration. Against this disparity the civil engineers very naturally appeal, and it might reasonably have been thought that the unsuitableness of the rules under which civil engineers have been placed, for any but natives of India for whose benefit they were originally framed, needed but to be pointed out fairly, in order that it might be immediately rectified. Such, however, has not been the result of the representations hitherto made on the subject, and in spite of the assertion recently made by the Under Secretary of State for India, with reference to the engineering service in India, to the effect that the Government "had created a new profession on a level with the two great Indian services—the civil and the military." Civil engineers in that service still find themselves in the cold shade with regard to the several points above mentioned, and the words of the Under Secretary of State for India remain as yet unfulfilled. It may be stated by some that civil engineers, having accepted their appointments with a full knowledge of the rules of the service into which they were entering, have no right afterwards to clamour for better terms, but to any such special pleading we must issue a most decided protest. To subject English gentlemen to the rules of a service which formerly, when those rules were formed, consisted almost exclusively of natives, merely because they happen to have been educated as civil engineers, whilst military men in the same service and department, holding identically the same appointments and responsibilities, are brought under a set of rules framed for Englishmen, because they happen to be military men, is an anomaly for which, fortunately, there exist but few parallels, and it is a point which defies alike justification or reasonable explanation. It cannot be denied that a great mistake was made at the outset in placing a highly educated body of men like civil engineers in what is known in India as the "Uncovenanted service," but a still greater mistake continues to be made in keeping them there. To deal with a question affecting the position of some 600 engineers, must undoubtedly, at any time, be a work of some magnitude. The injustice of the existing rules has, however, already been admitted; and how great soever may be the difficulty and expense of framing fresh rules for their benefit now, such difficulty and expense can only be aggravated by delaying the necessary measure until the numbers to be benefited shall have become considerably increased; and, at the recent rate of augmentation of the Public Works Department for current State works, coupled with the contemplated increased expenditure on irrigation works and State Railways, such increase of establishment threatens to grow annually to a very considerable extent. No doubt the executive is aware of similar grievances in other departments, the removal of which could not well be denied if civil engineers were to be granted all that from their position they are entitled to demand as their just rights. Such a consideration, however, would be quite unworthy of a Government such as that of India, as it would bear upon the face of it the appearance of deciding important cases according to expediency rather than according to right. To what, then, must we attribute the tardiness of Government in conceding that which has already been long since promised to civil engineers in satisfaction of their acknowledged and just claims?

Pending the receipt of a better reply to this question than we are at present in a position to suggest, let us briefly review the grievances of civil engineers in India, which at present require redress, and to which the attention of the Indian Government has recently been drawn by memorial from the civil officers of the Public Works Department. In the first place, then, as regards pay. The inequality of the pay drawn by military and civil engineers holding similar ranks in the Public Works Department, formed some time since the subject of a strong representation by the latter officers, and the anomaly of this inequality of remuneration for doing the same work was all the more apparent, since in no other department of the State did there exist any such distinction, the salaries attached to certain other appointments being at a fixed rate, whether those appointments were held by civilians or military men. The only explanation of the difference in this respect, prevailing in the Public Works Department, which we have seen, being that that is the only civil department for which Royal Engineers are elegible. However good an argument that may be for paying Royal Engineers more, it can surely be no justification for paying civil engineers less. This question of salary has, however, been for the present set at rest, by conceding a higher rate of pay to civil engineers, and in some instances lowering the previous emoluments drawn by military men holding certain appointments in the Department, so that the pay of the two branches has been brought more into accord. But, as stated by the Chancellor of the Exchequer, "a little too much has been made of the money question." The leave and pension rules for unfortunate civil engineers constitute a real grievance, whilst the recent table of precedence which has been framed, and which, it was hoped, would have accorded to civil engineers a certain recognised position in India, has turned out a complete farce, and so great are the anomalies contained in it, that it must perforce be speedily withdrawn, and give place to some better digested scheme for giving to officers holding similar rank in different departments of the State, whether covenanted or uncovenanted, military or civilian, similar recognised official rank. Rules which decide that on all public occasions a subordinate, if he be a military man, takes precedence of his departmental superior who may chance to be a civilian, carry upon the face of them their own condemnation. As the recent table of precedence must, therefore, shortly be reconsidered, we shall not now refer further to this branch of the subject, preferring rather to view it as being under consideration.

With regard to leave of absence, the civil engineer is, under existing rules, obliged to content himself with the same amount of leave and the same allowances in proportion to his salary which a native of India enjoys, whilst the covenanted civilian and the military man can, after a few years residence in India, recruit mind and body on ample allowances in Europe, and, as it has been very tersely put in an anonymous paper on this subject, "a civil chief engineer, 1st class, if obliged to seek for health in Europe, draws less allowance by 254*l.* per annum than a military executive engineer, 1st grade, an officer five grades his junior in the same service or department, just as if a brigadier-general received less daily pay than an ensign, an officer five grades in army rank below him." Military officers in civil employ in the Public Works Department are allowed to count a certain portion of their leave as service qualifying for pension, whilst in the case of civil engineers, leave on furlough or medical certificate does *not* count as service qualifying for pension. Such inequalities in the rules affecting members of the same department, holding similar departmental rank, and performing precisely the same duties, is an anomaly unjustifiable in itself, and necessarily injurious in its effects. We have above given but a few instances of how the rules of the service affect civilians and military men in the Public Works Department, with the view merely of pointing out the nature of their injustice, but not the full extent of it, which would require more space than we can afford on the present occasion, but we shall probably have to return to the subject at some future time.

In conclusion, we may say one or two words on the subject of the recent examination for direct appointments with reference to letters which appeared in Engineering of the 1st of September. We must dissent entirely from any proposition that that examination was not as conscientiously conducted as on any former occasion. The fact that two of the examiners were professors at the new Indian Engineering College does not, to our mind, afford any explanation of the reason why so few candidates passed. We can fully understand that in many cases considerable disappointment has been caused to the unsuccessful candidates, but deficiency in the requisite qualification can hardly be atoned for by unlimited abuse of the system under which that deficiency has been detected.

Merryweather's Fire Engines.—The Prussian dockyards are adopting the "Admiralty" pattern steam fire engines of Messrs. Merryweather and Sons. These are the most powerful steam fire engines introduced; they are capable of discharging 1200 gallons per minute to a height of 230 ft. through a nozzle 1¼ in. diameter. The English Government are provided with five such engines. Messrs. Merryweather are now building a fourth engine for one of the Prussian dockyards.

INSTITUTION OF CIVIL ENGINEERS.

The list of subjects upon which the Institution of Civil Engineers solicits papers for the ensuing Session is unusually comprehensive, embracing every branch of the profession, military engineering excepted. It is to be hoped that a free response will be made to the recommendations, and that the hints contained in the circular will be acted upon, for to respond to the invitation is an absolute duty which every engineer who possesses special opportunities for obtaining special information owes to the profession of which he is a member. Several difficulties, however, always lie in the way of the Institution in obtaining an ample supply of good communications, of which the chief are unwillingness to supply suitable contributions, and inability to do so. Many engineers whose experience would form an invaluable addition to the records of the Institution cannot spare time from their pressing duties to write a paper; many others have not the capability of placing their information in a suitable form for the requirements of the Institution. From these two causes it always happens that many valuable topics for discussion are lost. On the other hand, it sometimes occurs that many engineers, anxious to obtain the publicity a contribution would secure, press their services upon the Institution; others, with different personal ends to serve, are equally assiduous in their attention. We need not say, however, that few such contributions as these ever pass through the ordeal of the Council to engage the attention of the Tuesday evening audiences. Already the time of the Institution is taken up with two classes of papers, those read on the regular evenings of meeting for the general benefit, and those more special papers supplied by the students, the latter being often highly valuable, and followed by discussions more animated, if less profound, than those of the regular meetings. It occurs to us that a third class of communications might be advantageously admitted, not for public reading at the meetings—when the time is already too limited—but for publication in the *Transactions*. Such communications would be upon subjects highly valuable in themselves, but scarcely worthy of the dignity of a paper, and would form engineering notes upon a variety of subjects communicated by engineers, and containing the results of experience upon subjects of more or less importance. If such contributions were invited from engineers in all parts of the world, and if these were examined by the Council, classified, and duly published with the *Transactions*, we believe that a mass of information could be regularly and easily collected, which would add vastly to the value of the Institution records, and be obtained without expense or trouble. Such a course would be within legitimate bounds, and the request for contributions of this nature would, we are sure, be freely responded to by those who hesitate to devote themselves to the elaboration of long essays.

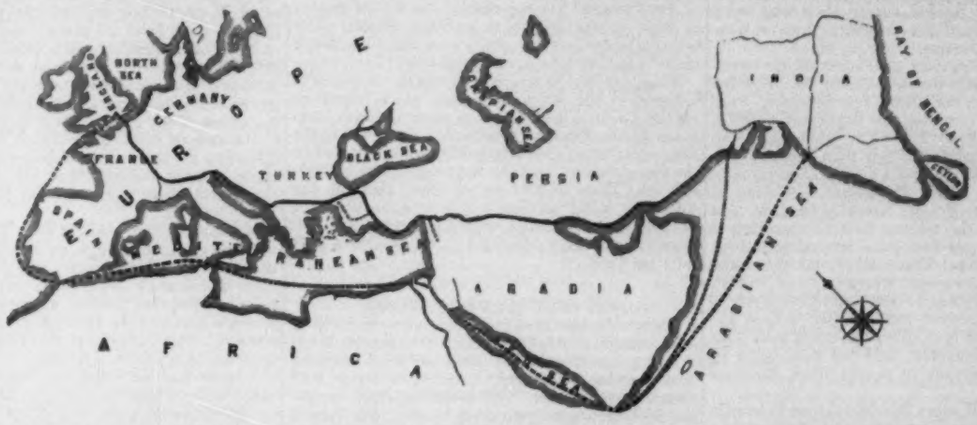
Nor could this suggestion, properly carried into practice, as the Council know so well how to do, ever give to the *Transactions* an undesirable tone. The duty of the Institution is to collect as much valuable professional information as possible, to place this information before its members for discussion first, for reference afterwards; and this end would be more fully achieved were the suggestions we have made acted upon.

The aim of the published proceedings of the Institution is closely allied to that of this journal, the means, of course, of achieving it being far different. In the one case a comparatively small number of subjects are thoroughly investigated and discussed, forming, at the close of each session, a mass of valuable and select material; in the other, a far wider range is necessarily taken, and with more frequent publication, it is impossible to devote—with a few exceptions—the space for essays of a class similar to those of the Institution. The conditions of journalism impose, therefore, certain restrictions, and leave much to be desired; but this want is supplied by the *Transactions* of the Institution, which form, as it were, a Quarterly Review of Engineering, and supplement, with their selected contents, the more general material we have the privilege of laying before our readers week by week. How to do this more usefully and more completely, year by year, is the unfailing study of the Institution, as is well evidenced by the result of their work; and it is needless to say that this is an example followed unceasingly by ourselves, with a full measure of success.

FROM LONDON TO BOMBAY DIRECT.

THE tendency to promote great international engineering works for international benefit and advancement which had been for some time steadily increasing before the outbreak of the Franco-German war was checked, but not in any way destroyed during the period of hostilities; and now before the equilibrium of events has been fairly restored, we find it again making its appearance, with every probability of success.

One of the most notable examples of this direction of energy, is the proposition to connect our Eastern possessions with this country by an unbroken line of railway communication which shall place us in direct connexion with India, and reduce the time required for making the journey to an extent so considerable that the commercial relations between Europe and the East would be established upon a new basis. But for the construction of the 5339 miles of line required for this undertaking not only would foreign capital be solicited, but the co-operation of various foreign powers would be necessary. At the smallest estimate some 24,000,000*l.* would be wanted to complete this work, assuming that the lines of railway through France, Austria, Turkey, &c., already in existence were placed at the disposal of the great company to whom the task would be intrusted. That such a capital could be easily raised, there is no doubt; that political negotiations could be accomplished, leaving no obstacles in the way, may be readily imagined; and that the engineering difficulties to be encountered are comparatively insignificant is certain. The policy, the utility, and the intimate mutual advantages to be derived are, then, the great questions to be considered.



Setting aside certain vague and nebulous propositions which have of late floated about for the construction of such a line of railway as is here proposed, we find that the scheme of Messrs. Low and Thomas is at present the only one we need allude to here. The published description of the scheme is set out in a letter addressed by these gentlemen to Mr. Gladstone, and it will be comprehended by an inspection of the above sketch plan. They propose to avail themselves of the direct route now open from Calais *viâ* Mont Cenis to Trieste, thence through Austria, utilising the existing lines, and building 385 miles of new railway. From Austria the route would pass through Turkey to Constantinople, involving the construction of 602 miles of line. The Bosphorus would be traversed by a steam ferry, and from Scutari the line would run through Turkey in Europe and Asia to the Persian frontier, a distance of 1630 miles. In Persia 855 miles must be built, and in Beloochistan 674 miles, which would bring the railway to Sinde, and thence to Kurrachee, making in all a distance of 5339 miles, of which 1170 miles are already built, leaving a balance of 4169 miles, a length only about 1000 miles in excess of the great Transcontinental line joining the Atlantic and Pacific. Upon this railway Messrs. Low and Thomas propose to run—besides the ordinary goods traffic and way trains—one fast train a day from the commercial centre of each of the powers interested in the undertaking, and to maintain sufficiently high speed and incessant travelling to complete the journey in 7½ days; they even anticipate a velocity of 50 miles an hour and a journey of 4½ days.

It is worthy of notice that, although the promoters of this scheme are amongst the most active agitators of a railway tunnel between England and France, they have not included this in their proposition. This shows a wise discretion, for had they done so, there would have been established a stumbling-block on the threshold of the enterprise that would have placed the matter almost beyond the field of discussion.

As it is, they are fairly entitled to that consideration which is the due of all earnest men who put forward a plausible scheme, practically clothed, and sensibly advocated.

The estimated cost of the undertaking, as we have said, is 24,279,000*l.*, an amount proposed to be raised by different companies on behalf of each country interested, and for the respective amount of work to be done. In the outset we should imagine that a grave difficulty would be found in raising the necessary capital in those countries where the largest amount of work had to be done, but where money, energy, and apparent future interests are most scarce. But setting this aside, another obstacle arises, fatal, in our opinion, to international co-operation. From one point of view, it would be exceedingly convenient for Austria, Turkey, Persia, and Beloochistan to subscribe their millions, but from another point of view, it would be exceedingly unprofitable. Exactly the same argument against co-operation in the construction of the Channel Tunnel is applicable to the England and India Railway, but, of course, on a larger scale.

To England France is the highway to the eastern world, to France England is the road to—England. Invaluable to this country as is her "silver streak," in this particular case, it has its disadvantages, and perverse French capitalists could not be convinced that they would be equal gainers with ourselves in this enterprise—after it was finished. And this same objection would hold with infinitely greater force against the England and India Railway. To ourselves, such a line in time of peace would be doubtless invaluable; but the advantages to the other powers interested would steadily decrease eastwards, while the extent of works required would increase in the same degree, and the ability to provide capital would diminish as regularly. It may be argued that, with the completion of the railway, trade along the whole route would be vastly stimulated, and that the limits of the created traffic could scarcely be set; but this is, of course, speculative, while the benefit to ourselves is clear and distinct. Under these circumstances it would be quite reasonable for all the powers interested to urge that giving running powers over such lines as are constructed, and permission to lay down the connecting links, would be equivalent for any contingent advantages they may derive. In England and India, therefore, the whole of the required capital would probably have to be raised.

It is possible, though, we believe, improbable, that any serious effort will be made to raise the capital within the restricted area which policy prescribes, and that encouragement will be derived from the fact that already a line has been constructed in America—where capital is less plentiful than here—only 1000 miles shorter than the new works in question, but the circumstances under which the Pacific Railroad was built were far different to those that would rule the England and India Railway. Running through no foreign territory, the end it serves is entirely national; it has opened up vast tracts of new country, which are now becoming populated and developed, thanks to the land grants along its route; and in time of war it would be always more or less serviceable. With the England and India Railway the conditions are totally changed. The latter would serve one great and useful end—the trade of India and this country; it would during peace facilitate our military operations in the East, an advantage we should hold only at the mercy of circumstances, and it might be turned against us by the chance of war. The real value of such a line would thus be tested by the simple examination as to whether the advantages rendered to our Eastern trade would warrant the investment of 24,000,000*l.* of capital in a line held upon an uncertain tenure, or whether the cheaper and more moderate proposals which have so long been advocated for the Euphrates Valley Railway are not more in keeping, at all events with present trade prospects. There is a limit beyond which rapid communication becomes too costly to pay for, with all its attendant advantages, and we hold that the proposed England and India Railway far exceeds this limit.

THE OPENING OF THE MONT CENIS TUNNEL.

(*From a Special Correspondent.*)

BARDONNECHE, Sept. 18.

YESTERDAY the Mont Cenis Tunnel was officially opened by a ceremony at which France, Switzerland, Austria, and Germany, were represented, but I am not aware that England followed this example. It appears strange that so great a triumph of genius over matter should have been solemnised by the triumph of matter over genius, that is, by colossal eating at a splendid banquet. About 1500 invitations for the occasion were sent to the most prominent men of Italy, and to some few of the élite of Europe. The demand for these invitations was so great that for want of room, even the members of the technical staff, who have contributed to the accomplishment of the great work, were unfortunately partially excluded, being represented only by about a dozen of the leading engineers, a circumstance which was much to be regretted.

Three trains bore the distinguished crowd from the splendid station of Turin to Bardonnèche. Very few of those who travelled along the barely finished Alpine Railway in evening dress at six in the morning, gave a thought to all the privations those who built it had endured, the exertions they had made, and the difficulties they had surmounted in order to complete the road for some wool-sack or newly married couple to travel more quickly, cheaply, and easily from France to Italy.

Leaving philosophy behind us as easily as we left stone arches of 90 ft. span, lattice girder bridges of 180 ft. clear, and viaducts 120 ft. in height, we arrived at Bardonnèche with the last train of the three which quitted Turin for the tunnel. The first train had already entered the long gallery in which powerful petroleum lamps cast their lights in a circle greatly restricted by the intense obscurity which prevails in the tunnel.

This train bore M. Grattoni and many of the greatest dignitaries of the State to Modane, where it was to pick up M. Le Franc, the French Minister of Commerce, General Menebrea, and many other men of note. The trains, which started after the first from Turin, stopped at Bardonnèche, and those who had travelled in them, among whom we noted about 34 ladies, the Princess Pallavicini, the Marchioness San Germano, the Countesses Rignon, La Trinita, Zoppi, and others, ascended a steep path leading to an immense embankment made of the spoil from the gallery, and on which the banquet hall had been erected. We all entered this hall, which was, I must confess, decorated in most exquisite taste, and most ingeniously arranged. One side of it was almost entirely open, and offered to the admiring eye the splendid panorama of Bardonnèche, and the buildings in which the staff and workmen had resided during their long task; the peculiar aspects of the air compressors particularly attracting attention.

In the meanwhile, some gentlemen of the commission, appointed for the reception of the numerous and select guests invited to the banquet, were busily engaged in resolving the important question of who was to take preference of whom, and who was more particularly somebody than any one else. We noticed that on the grand master of ceremonies of the kingdom, Count Panissera, the Duke of Sartirana, and Mr. Francis Kossuth (the heir of a noble name), fell the tedious task of awarding to Cæsar what belonged to Cæsar, arranging and re-arranging the tickets which marked out the places of the great men of the earth who were to be present. The Dukes of Argyll and Sutherland thus revolved more than once around the banquet hall, in the form of a card, but both these noblemen took their revenge for the locomotion they had to undergo by proxy, by being absent in person when the time came.

The banquet hall, more than 100 metres in length, was entered all at once by the crowd of guests who took their seats round the tables which were laid in two parallel lines all along the hall. Not much attention was paid to precedence, and places pointed out for dignitaries of the State were boldly taken by some eager correspondent. All the great men present were very reasonable, however, and the representative of Austria alone insisted on eating higher up than the representative of a power who has once nearly eaten up Austria—I mean Prussia.

The banquet went along as all other banquets do, with this exception, that the French minister, Le Franc, rose for a toast before the dinner was half finished, and his rising prevented a few hundreds of people from accomplishing more than half the great business of the day. M. Le Franc began by sketching a short history of the grand work which had been accomplished, and on this subject he was not at all fortunate; he then spoke of the departed who had contributed to the colossal undertaking; his eloquence rose as he spoke, and became stirring in presence of the shadows of Sommeiller and Cavour. He maintained himself on the same high level for the rest of his address, which he concluded by pointing to the Mont Cenis Tunnel and to the canal of Suez, both accomplished by the Latin races, and appealed to them as to great proofs that the Latin race is not declining in spirit, though lately mastered in war in the person of its foremost representative. He then drank to the country whose working classes dedicate their power to the accomplishment of such works as the tunnel of the Alps, and not to the overthrowing of society and to the burning down of the monuments former ages had left.

After M. le Franc, M. Devinceni and M. Sella, two Italian ministers, spoke, followed by M. Lesseps, of the Suez Canal; next spoke M. Amilhan, the director-general of the railway company in the province to which the tunnel will belong, and he offered in the name of the company a gold medal to Italy, one to France, one to Grattoni, and another to Grandis. The last speech was delivered by M. Grattoni, who spoke with emotion of Sommeiller.

Naturally I much regretted to see that, doubtless owing to the confusion and to the emotion of the moment, though almost each orator mentioned Sommeiller incidentally, and though toasts were drank to France, to Italy, to those who accomplished the great work in general, and to Grattoni in particular, no one thought of drinking exclusively to the memory of Sommeiller.

The number of those who were allowed to speak was very restricted, and hence, although I noticed and regretted very much this omission—having been particularly and personally acquainted with this great man, who like Moses never reached, though he lived to see the promised land—I could only raise my glass with a few of those around me, to the most deserving of all the deserving, to Germano Sommeiller!

We came back to Turin in very agreable company, and arriving at half-past nine found the town splendidly illuminated, all the architectural outlines of the central station (which probably is the most monumental station in Europe) were lighted up with coloured lamps, a transparency in the centre representing France and Italy hand in hand in front of the tunnel. The street which runs before the station was arranged so as to represent a tunnel of gaslights and coloured lamps, while the entrance of Bardonnèche was represented the size of nature in front of the gallery in outlines of fire. The principal streets of the town were also illuminated more or less with taste and splendour.

Next day the municipality prepared a splendid banquet at the Palladian Palace, which stands on Piazza Carlo Alberto, and a *concert monstre* was given on the Piazza of the Castle. On the 19th the king entertained the distinguished guests invited to the inauguration. All the important cities of Italy had sent their mayors to represent them at the solemnity, which will leave, I believe, in the minds of every one a profound impression and a lively remembrance of the cordiality with which all strangers were received.

THE OXY-HYDRIC LIGHT.

The production of a light, the nature and cost of which should enable it successfully to supersede the yellow glimmer generally obtained from ordinary coal gas, has long been a favourite study with chemists and others. The combination of oxygen and hydrogen gases, variously treated, has formed the basis of most inventions having this object in view. But although in many instances the results of practical experiments have demonstrated the fact that such a light can be produced, yet an exposition of that fact on a commerical scale has never been effected until now. This has been due either wholly or in part to complication in manufacture, difficulty in application to purposes of general utility and costliness of production. In fact, the chief difficulty has ever been the expense attendant upon the manufacture of the oxygen gas. The joint researches of Jessie du Motay and others, however, have led to the discovery of a means of producing this gas at about the same cost as hydrogen. Advantage has, therefore, been taken of this circumstance to produce a cheap and efficient light by the admixture of the two gases, in certain proportions. Common hydrogen is highly carburetted and mixed at the burner with oxygen in the proportion of about 2 of the former to 1 of the latter, which burns with a pure white flame. This constitutes the oxy-hydric light, with which the city of New York was partly lighted about a year since. Previously to the outbreak of the recent continental war a part of Paris was also lighted by this means, and we understand that the same system is about to be adopted in Vienna and Brussels. A company is now being formed in London for the purpose of introducing the new light in this country. With the view of proving the economy of this gas—for its use is stated to involve a very great saving over ordinary gas—a series of lengthened practical trials are about to be made at the Crystal Palace, where apparatus for its production on a large scale is now being fitted up. We reserve the details of manufacture until these arrangements are completed; in the meantime it will be sufficient to say that a laboratory examination of the matter and a comparison of the purity and intensity of the oxy-hydric flame with that of ordinary coal gas, tell very greatly in favour of the new light.

The St. Gothard Railway.—The St. Gothard Railway with a tunnel about the length of that of the Mont Cenis will, it appears, very soon be commenced. The capital necessary for the tunnel is about 60,000,000 francs, and for the lines to join the Italian and the Swiss Railway about 125,000,000 francs. Subsidies to the extent of 85,000,000 francs have been voted by Germany, Italy, and Switzerland, and the remaining 100 millions will be taken by a syndicate, 65,000,000 francs in bonds, bearing 5 per cent. interest, and 35,000,000 francs in shares. It is estimated that at least seven to eight years will be required for the entire completion of the work.

LITERATURE.

The Rule of the Law of Fixtures, by Archibald Brown, Esq., Barrister-at-Law, M.A. Edin., and B.A. Oxon. Reprinted, with additions and alterations, from the *Law Magazine*. London: Butterworths.

"The Rule of the Law of Fixtures" is an attempt to gather up in one manageable formula all the numerous factors or elements requiring to be considered in advising upon modern cases; it also attempts to arrange these factors, or elements, in the order of their relative importance." It is thus that Mr. Brown describes in his preface the character of the book under notice, and the sentence gives such a fair idea of the general scope of the work, that we have considered that we could not do better than quote it here. The book commences with an interesting epitome of the history of the subject, in the course of which the author explains the rigorous laws in force in the "good old times," and points out how as trades and manufactures became developed there gradually obtained a more and more liberal interpretation of the enactments which in former days gave such powers to the landlord, and so limited the action of the tenant. It is upon a consideration of the various cases exemplifying this gradual modification of the law of fixtures as well as upon more modern decisions that Mr. Brown has established his "rule," and we must now explain what that "rule" is.

Our author shows that in early days any agricultural erection, buildings, or erections, "instantly and invariably became part and parcel of the soil upon which, or in which, they were set up;" and he points out that this law was justified by the fact that the land and the agricultural fixtures founded upon it for the purpose of carrying out its cultivation, had a special relationship to each other. In the same way he considers that in dealing with other matters than land simply, and in attempting to determine how far any detail or adjunct of a certain *res principalis* is or is not a "fixture," it is above all things desirable, in the first place, to determine the exact character of the *res principalis*, and then to ascertain whether there exists between this "main body," as it may be termed, and the detail under discussion, any such relationship as that to which attention has been directed in the case of land and agricultural buildings. Continuing his survey of the modern law on the subject, Mr. Brown traces out, with much ability, the application of the principle just mentioned, as exemplified in the decisions given in numerous important cases, the shades of difference in the circumstances of these various cases, and their bearing upon the decisions arrived at, being carefully pointed out. Although strictly a "law book," the work before us deals with matters of such general interest, that it will be found well worthy of perusal by large numbers of readers who have no connexion whatever with the legal profession. Engineers, manufacturers of all kinds, agriculturists, landlords, and ordinary householders, will find much information in its pages which it is advisable that they should be acquainted with, and they will also find that Mr. Brown conveys this information in a very clear and readable way.

EXPLOSIVE COMPOUNDS.

Various Explosives.

In the series of articles upon the subject of explosive compounds which have preceded the present, we have dealt successively with gunpowder, gun-cotton, and dynamite. We have now to consider various compounds designed to supersede gunpowder, and which have been tried and have proved more or less successful. One of the most promising of these compounds was introduced to public notice in England in 1866. This was a new blasting powder, the invention of M. Neumeyer, of Tauchs, Saxony, and which was termed "inexplosive," inasmuch as there was no possibility of exploding it, either during its manufacture, storage, or manipulation. Not until the proper moment for ignition had arrived, when it was well rammed home and prepared for its work, was its energy developed. When fired under those conditions it manifested a power, weight for weight, considerably in excess of that produced by gunpowder. Although this powder differs in colour as well as in action from gunpowder, in that it is slow burning instead of being violently explosive when fired in contact with the atmosphere, it is stated to be composed of precisely the same materials as ordinary gunpowder. No other sub-

stances are added, the special results arising simply from the method of proportioning and compounding the ingredients. A reduction is made in the amount of sulphur employed by which means a much smaller quantity of the noxious vapours is evolved on its ignition than is produced by the combustion of ordinary gunpowder; a point of some importance in mining operations. Some difference is made in its preparation according to the purpose for which it is required, whether for use in firearms or in mines. For the former purpose the result is a grained powder which, when hermetically confined, explodes at the same temperature as ordinary gunpowder, whilst as prepared for blasting purposes it is in a state of meal and requires a somewhat higher temperature to explode it. This is an advantage as it renders the chances of premature explosion more remote, its ignition being readily effected in the blast hole by Bickford's safety fuse which is now extensively used in our own and continental mines. Although no coating or glaze is imparted to this powder in manufacture, it is not more hygrometric than ordinary gunpowder, whilst if wetted and dried it is said to retain all its good qualities.

Neumeyer's powder was fully tested in England towards the close of 1866 and in the early part of 1867. The tests applied conclusively proved it to be inexplosive when fired in contact with the open air, but violently explosive when confined ready for work, either in a rifle or a blast hole. The tests for inexplosiveness were carried out in the Crystal Palace grounds* in December, 1866, the most conclusive being the firing of 35 lb. of the powder—half blasting and half rifle powder—in a small brick house 5 ft. square roofed with slate and fitted with two lengths of 5-inch drain pipe for chimneys. On igniting the powder a large body of flame issued through the openings, but neither bricks nor slates were disturbed. On 3 lb. only of ordinary gunpowder being placed inside the house and fired, a violent explosion took place which rendered the building a mere wreck. The tests for explosiveness and working power were made on a practical scale at the Bardon Hill and the Markfield granite quarries, near Leicester. In both cases the blasts were highly satisfactory, the results being in some instances superior to those obtained from gunpowder. It was found, too, that in a hard compact rock the effect produced by a given quantity of powder was greater than that produced by an equal quantity in a soft or loose rock. This powder was also tried with equal success at the quarries of the Welsh Slate Company, Rhiwbryfdir, Carnarvonshire, and subsequently at the slate quarries of Messrs. Matthews and Sons, Festiniog. The concurrent testimony of those connected with the quarries, and who conducted the experiments, went to prove the adaptability of Neumeyer's powder for that purpose. It was also tried in coal and in copper mines with equally satisfactory results, but notwithstanding all this, and although of so promising a character, all endeavours to render it a commercial success in England failed. In Germany, however, we believe it still continues to be extensively manufactured and used, M. Neumeyer having erected large mills with steam power for its production at Attenburg and two other places in Germany, about five or six years since. This material is worthy of notice as being the only explosive in the condition of grained powder which has proved superior to gunpowder for blasting; which can be used in firearms; and which really embodies comparative safety coupled with greater energy than ordinary gunpowder.

Considerable attention has been given to the production of an explosive by the incorporation of chlorate of potash with other ingredients which should tone down its violence. To some extent the compounds thus produced have been found successful as regards power, and—with careful manipulation—safety. But chlorate of potash is a dangerous substance to deal with at the best, and until a method of rendering it safe is discovered it will remain so. M. Ehrhardt's powder was of this class, its ingredients being, for blasting powder, chlorate and nitrate of potash each one part, tannin two parts, and charcoal four parts. For artillery Ehrhardt omitted the charcoal and used equal parts of the other ingredients. Mr. Horsley claims the invention of Ehrhardt's powder, and in practice he produces a very powerful blasting agent composed of chlorate of potash and gall-nuts in the proportion of three to one. Mr. Horsley prepares this powder by grinding the two ingredients very fine and intimately mixing them in a wooden mortar with a pestle of the same material. As this powder is liable to be exploded by a blow an alternative method of mixing, also adopted by Mr. Horsley, appears the safer where large quantities are required. This consists in passing the ingredients through a series of horsehair sieves arranged one below the other and having a rocking motion imparted to them. Upon the upper sieve the two ingredients are first mixed by being run together from two receptacles placed above the sieve, one containing a given weight of chlorate of potash, and the other one-third of such weight of gall-nuts. The chlorate being much heavier than the nuts, the volumes of the two are about equal. The sieves are set in motion and the two finely pulverised ingredients pass downwards through them and so become blended and form the explosive compound.

Horsley's powder has been used for blasting in a railway cutting at Milford without accident and with success. It has also been used with excellent results by Captain Harvey in experiments with his torpedo. Some years since Mr. Horsley submitted this powder to the Government, but it was objected to on account of its detonating properties, the test at Woolwich having been to strike it on an anvil which of course exploded it. The temperature at which this powder explodes varies from 430° to 460° if the heat is suddenly applied. When, however, the temperature is gradually raised, the powder will char and become inexplosive. The powder is also exploded by concentrated sulphuric acid. Mr. Horsley considers his compound a safe one, and it may be so in his or other equally careful hands, but beyond this we are by no means prepared to endorse his opinion. That it is exceedingly powerful we have no doubt as we have seen its disruptive effect, as compared with that of gunpowder, on some elm blocks. Equal charges of Horsley's powder and fine grain sporting powder were fired from an eprouvette at right angles to the wood and 1 in. from its face. Horsley's powder tore apart the fibres and made a hole in the wood whilst the gunpowder left little more than a mere smoke mark upon its surface.

(To be continued.)

* *Vide* account of trials on p. 472, vol. ii., of ENGINEERING.

OLDHAM SCHOOL OF SCIENCE AND ART.—Three Queen's medals have been awarded by the department to artisan students of this school. The silver medal for mathematics to John Armitage, a bronze medal for machine construction and drawing to John Robertson, a bronze medal for applied mechanics to Thomas Marsden. John Armitage has also gained a Whitworth scholarship this year.

SURVEY AND MAIN DRAINAGE OF HECKMONDWIKE.—At a meeting of the Heckmondwike Local Board held on Monday the 25th inst., Mr. M. PATERSON, C.E., of Dewsbury, was unanimously appointed to carry out a complete survey of the district to a scale of 10 ft. per mile, and to lay out a system of main drainage. Heckmondwike, although a manufacturing town of 9000 or 10,000 inhabitants, and steadily increasing to importance, has hitherto been without any connected system of sewerage.

STEAM YACHTING.—A new iron screw steam yacht, named the Mona, has just been built for Lord Howe by Messrs. Day, Summers, and Co., of the Northam Iron Works, at Southampton, which was tried at the measured mile in Stokes Bay a few days since with the following results: 1st run, 65 lb. steam, 89 revolutions, 5 minutes, equal to 12 knots per hour; 2nd run, 65 lb. steam, 88 revolutions, 5 minutes 14 seconds or 11.46 knots; the mean speed being 11.73 knots, or 13½ statute miles per hour. This rate of speed is the more satisfactory, as it has been proved that the Mona is able to keep it up at sea. She has steamed round the Isle of Wight, a distance of 60 miles, in 4 hours and 40 minutes, and on her late cruises to the Channel Islands, Cherbourg, Dieppe, Plymouth, and other places, she made on an average between 11 and 12 knots per hour. The Mona is a very handsome yacht, with two masts, and is rigged as a fore and aft schooner; length between perpendiculars, 140 ft., beam, 20 ft., depth from base line to under side of deck, 13 ft. 0 in., tonnage, builders' measurement, 372. She has a very spacious saloon, with a clear head room of 7 ft., and the sleeping cabins are provided with baths sunk in the floor, which are filled direct from the sea, and emptied into the bilge. The yacht is fitted with Day, Summers, and Co.'s compound engines of 60 horse power, nominal, diameter of high pressure cylinder, 20 in., low pressure ditto, 40 in., with a 2 ft. stroke. The steam is expanded about eight times, and the results are extremely favourable in economy of fuel. The Mona is found to steam 250 miles per 24 hours, with a consumption of 4 tons of coals. The application of the compound engine to yachts will effect a complete revolution in the yachting world. Hitherto the great drawback to the use of steam power in a yacht was the large quantity of coal consumed by the old class of engine, and consequently the frequent necessity of putting into port for fresh supplies of fuel, with its attendant inconveniences. But the improvements carried out in the Mona's engines will enable a yacht of her size to carry sufficient coal for a voyage to New York, steaming all the way.—*Times.*

NOTES FROM PARIS.

PARIS, Sept. 26, 1871.

THE MONT CENIS TUNNEL.

THE inauguration of the tunnel has caused less animation than might have been expected. Comparatively few engineers responded to the invitations addressed to them. The Lyons Railway Company was not represented, and we hear of misunderstandings between that powerful company and those with which its lines have just been connected.

THE IMPERIAL YACHT HIRONDELLE.

The steam yacht Hirondelle is at this moment in Cherbourg undergoing alterations, which will adapt her for the reception of heavy guns. This vessel during her short existence has passed through some singular vicissitudes.

Constructed in 1869 for the special service of the Emperor, she was an interesting experiment combining the latest improvements in naval construction. The Hirondelle was built for the accommodation of a limited number of passengers, the draught of water at the stern did not exceed 15 ft. 1 in., and the guaranteed speed was 16 knots an hour, with space for carrying two days' supply of coal at this rate. The hull was built of wood, by M. Normand, of Havre, with a double framing strengthened with diagonal stringers and longitudinal beams.

The boilers are of high pressure, inexplosive, of the Belleville type, already largely employed in several small Government boats and of wide adoption in France. They are composed of twelve steam generators giving collectively 340 square feet of grate surface, and the working pressure is 57 lb. per inch. The total weight of these boilers in working order did not exceed 108 tons. The two engines designed and constructed by the Company des Forges et Chantiers de l'Ocean, are vertical, each with two cylinders 39⅜ in. diameter and 23⅝ in. stroke, connected with the main shaft by two cranks at right angles. The distribution of the steam and the reversing is effected in each engine by means of an ordinary link motion. The nominal speed is 150 revolutions and the indicated horse power is 1800.

The two condensers are tubular for effecting the complete separation of the steam and condensing water.

The various parts of the yacht have been executed with the greatest care; the lines of the ship are elegant; the hull is at once solid and light; the accommodation is convenient; the masts, yards, and rigging are of moderate proportions, but ample to help the ship at any crisis and to check the rolling; the appearance of the engines is satisfactory despite the limited room available for them; the boilers are able to withstand very high pressures, they are very secure from explosion, they occupy but little room, are light, and not cumbrous, and the space they take up in all is 10,350 cubic feet.

The Hirondelle was submitted at first to numerous trial trips. These trials, commenced in October, 1869, showed the necessity of some modifications; the alteration of the screws amongst others. On the 21st—23rd of March the performances were again tested. On the 21st there was ascertained by the trials on the measured line at Cherbourg, the maximum power the engines could develop, and the highest speed that could be obtained; the draughts of water were 10 ft. 11 in. and 12 ft. 10 in. fore and aft respectively; the immersed section amidships was 248 ft., the sea was calm, the breeze light, six runs with full steam were made with a mean speed of 16.41 knots and a horse power of 2125 indicated, with a speed of 120 revolutions. Two runs with half fires gave a mean velocity of 13.43 knots with a horse power of 1026 and 94 revolutions per minute.

On the 22nd of March the double trip from Cherbourg to the Isle of Wight was made with all fires lighted, but without forcing them, that is to say, they were maintained in their normal condition, and on the 23rd she went from Cherbourg to Havre under the same conditions. In crossing to the Isle of Wight the mean horse power developed were 1748 with 111.5 revolutions and an average speed of 15.95 knots; the crossing occupied three hours and a half. The run back was effected in four hours with an average speed of 15.58 knots and a mean power of 1663 horses corresponding to 108.5 revolutions per minute. Lastly, the third trip from Cherbourg to Havre showed 1766 horse power, 16.079 knots, and 112 revolutions.

On reaching Havre an examination of the engines showed that nothing was disarranged, the various parts were in good condition, and the boilers also were perfect.

After the conclusion of these trials there still remained a good deal to be done to the Hirondelle at Havre, so that she was scarcely ready for active service before the commencement of the war. But by this time circumstances had changed; no longer a pleasure vessel, the yacht from July 1870 to July 1871 was employed on the most active service in the North Sea and in the Channel. When in December and January the land communication had been cut by the Prussians, this fast boat fulfilled the despatch service between Cherbourg and Calais, and was remarkable for regularity, arriving always in time in any weather. On one occasion the Imperial yacht conveyed M. Gambetta from Boulogne to Calais in one hour and ten minutes (distance 22 miles). It was kept under steam for 1735 hours without the boiler requiring the least repairs, although the water was very bad. Steam is always raised very rapidly, the time required never exceeding a quarter of an hour.

During her term of service the Hirondelle has had to pass through very heavy weather, and the severe gales so

frequent during winter in the North Sea and the Channel; but the boat, thanks to her good construction and great power, has shown herself superior to the worst occasion.

Now the Hirondelle is again being changed, and will soon be converted into one of the vessels forming the French navy. As a gunboat we shall be able to study the suitability of her arrangements under entirely new circumstances.

Restoration of Bridges.

M. Cadot, Ingénieur des Ponts et Chaussées, has just reconstructed in masonry a suspension and a timber bridge, following a new method, which appears greatly to facilitate these works, and to promote considerable economy. The suspension bridge of Tournus, over the Saône, is composed of five spans, each of 91 ft. 10 in., resting on two masonry abutments, and four intermediate piers. The width was 26 ft. 2 in. between the handrails, and the traffic was very considerable.

Timber piles were first driven under the bridge to carry the centering, leaving, of course, sufficient openings for the requirements of navigation; then demolishing the platform for one-half of its width; and concentrating the traffic on the other half, one portion of the centres were placed in position. On these were placed a temporary platform, on to which the traffic was directed, whilst the rest of the old platform was destroyed. The second half of the centres being completed, the permanent arches were built, but only for half their width. These arches were built with a first course of brickwork, left to set before the work was continued, then with other courses of brick and stone. A temporary roadway was constructed on these arches, which gave an available width of nearly 18 ft., and an overhanging side-walk of timber was also constructed. This half of the bridge being open, the traffic was again diverted from the temporary platform, and the rest of the bridge was completed in a similar manner. Lastly the permanent roadway, 18 ft. wide, was made, with two footpaths, each 3 ft. 10 in. wide, the timber walks being removed, and the permanent parapets erected.

The centres were struck a month after, and no settlements nor fissures were visible. The arches, 88 ft. 7 in. span, have 11 ft. rise, 35 in. thickness at the crown, and 3 ft. 10 in. at the springing. The total cost of reconstructing this bridge amounted to 150,000 francs, of which 40,000 francs were spent in temporary works.

The economy of this system depends on the facility for avoiding the construction of temporary bridges, and on the reduction of the dimensions in the centres on account of the method of construction employed named above, in which the first course is allowed to set before the second course of brickwork or masonry is superimposed.

The Rocks Pierced in Mont Cenis.

M. Elie de Beaumont has contributed to the Academy a collection of 196 samples of rocks passed through in the piercing of the Mont Cenis Tunnel. This collection, which has just been completed, is accompanied with a catalogue, included in the *Compte Rendu* of the Academy. The study of these samples permits us to divide into six zones, the ground cut by the tunnel:

1. The anthracite zone that is first followed in leaving Modane after traversing 420 ft. of loose earth, and which is the most elevated in the order of superposition of the beds. It represents an oblique thickness of 6454 ft. 6 in., corresponding to a real thickness of 3732 ft. 3 in.

2. The quartzite zone, 1251 ft. 3 in. thick, following the axis of the tunnel, and of an absolute thickness of 725 ft. 6 in., the thinnest and best defined of all.

3. The gypso-calcareous zone, of an oblique thickness of 2915 ft., and an actual depth of 1627 ft. 3 in. It presents a host of remarkable mineralogical developments. There are found there calcareous crystals, sometimes massive and almost pure, sometimes schistous and mingled; anhydrite, talcous schist, and quartz-sprinkled schistoids. This zone, although comparatively thin, is called by the engineer, Sismonda, "La grande masse calcaire." This formation is strongly marked on the surface, and presents bold outlines that strike the eye.

4. The upper calcareous zone, which has an oblique thickness of 9104 ft. 10 in., and a normal thickness of 5263 ft. 11 in. For the most part its composition is very uniform, the schistous element being predominant, diminishing in the lower part of the zone where the calcareous element is most marked.

5. The middle zone of calcareous schist which the tunnel traverses for 8563 ft., and the thickness of which is 4950 ft. 6 in. It is characterised by the presence in the calcareous schist of a quartz ore sand, known as silicious crystalline calcareous schist.

6. Lastly, the lower zone of calcareous schist, which extends to the Bardonnèche opening of the tunnel. Its oblique thickness is 11,482 ft. 11 in., corresponding to a depth of 6638 ft. 8 in. It is characterised by the predominence of the calcareous in relation to the schistous element.

The element which most affects the general aspect of the greater part of the rock pierced by the tunnel, is black argillaceous schist. The most extended is the element of talc, that is to say, that greenish mineral, soft to the touch, generally called talc, without precisely meaning that it is a silicate of magnesia with or without water. The third characteristic element is the quartz ore sand, generally quite fine, composed of little grains, amorphous for the most part, of almost colourless hyaline quartz. Lastly, comes the carbonate of lime, which forms the mass of more than half the specimens of the collection.

Crystallisation has almost caused the fossils to disappear, especially the belemites so frequently met with in parts of the same extended formations that have not been disturbed.

The beds found in a horizontal position have been lifted to an inclination of 50 deg. This movement has given place to the attrition to which a great number of specimens bear witness. The six zones are very distinct, and the reports of the engineers during the progress of the work, give ample information for ascertaining with precision the exact dimensions and characteristics of the formations.

The essay of M. Elie de Beaumont is in part extracted from a memoir by M. Sismonda, published in 1866. This memoir included a section prepared at the time when the work of piercing the Alps had just commenced. This section has been exactly verified by the experiences obtained in making the work.

The tunnel is in effect a horizontal boring, presenting over ordinary vertical borings the advantage of a great length, and of a section that permits the most extensive observation. It enables, moreover, the observations deduced from the data afforded on the surface to be checked with those made in the interior of the earth.

The Lafayette.

To-day's telegrams announce that the magnificent steamer Lafayette, of the General Transatlantic Company, took fire yesterday at 2 a.m., in the port of Havre, just as it had arrived from New York. At 8 o'clock the rear of the ship, loaded with corn, fat, and other combustible merchandise, was in flames, the masts fell, and there was little hope of saving the ship and her cargo. The loss is estimated at more than 4,000,000 francs.

RECENT PATENTS.

The following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

(No. 2712, 10d.) William Bruce Thompson, of Dundee, patents fitting vessels with hydraulic or other packing presses for facilitating the stowage of loose materials, such as flax, hemp, &c. Mr. Thompson proposes to fix the press so that the sole plate extends across the hatchway, the object being to treat the material as it passes to the hold. We much doubt whether a patent for the fixing of a packing press in any particular position on boardship could be maintained.

(No. 2721, 1s.) John Coope Haddan, of 41, Trehernes-road, and John Imray, of 28, Great George-street, patent the apparatus for taking and registering votes which we noticed in our account of the last conversazione at the Institution of Civil Engineers (*vide* page 403 of our last volume).

(No. 2725, 3s.) David Greig and Max Eyth, of the Steam Plough Works, Leeds, patent arrangements of ploughs, harrows, &c., which are well worthy the attention of those interested in steam cultivating apparatus, but which we have not space to describe here. At some future time we may probably give an account of these plans.

(No. 2729, 6d.) George Bell Galloway and George Thomas Galloway, of London, patent what they term "improvements in the production of motive power, and appliances connected therewith." This is a very rambling specification referring principally to schemes for pumping back the exhaust steam of engines, mixed with air or water, into the boilers. The descriptions of Messrs. Galloway's plans contained in their specification do not enable us to discover their merits—rather the reverse.

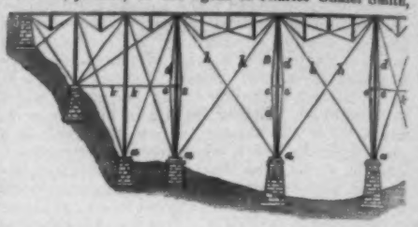
(No. 2733, 10d.) David Laidlaw and John Thomson, of Glasgow, patent arrangements for propelling omnibuses, &c., by compressed air. The patent particularly refers to forms of air compressing pumps having two or more cylinders of different sizes in which the air is successively compressed, and forms of air storage reservoirs built up of tubes of moderate diameter so as to be capable of withstanding a high pressure. The air drawn from these reservoirs is passed through a reducing valve on its way to the propelling engines. We believe that the circumstances under which compressed air can be profitably employed as a propelling power are exceedingly rare; but Messrs. Laidlaw and Thomson's plans have been worked out with a care which entitles them to notice.

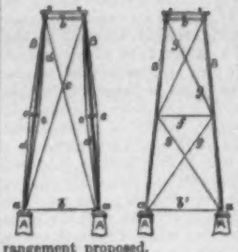
(No. 2748, 10d.) Brierley Denham Healey, of Glasgow, patents methods of heating steam boilers by gas which is generated in gas producers somewhat resembling those employed by Mr. Siemens, and which is supplied with air which has been heated by passing through tubes which traverse the boiler flues and which are thus exposed to the burning gases.

(No. 2763, 2d.) Matthew Andrew Muir and James McIlwham, of Glasgow, patent machinery for making wrought-iron railway sleepers which we could not describe briefly.

(No. 2797, 6d.) Ernest von Jeinsen, of San Francisco, U.S., patents fitting each bearing of shafting, &c., with a collar at the middle of its length, this collar revolving in suitable recesses in the brasses and dipping into an oil reservoir from which it takes up a supply of oil as the shaft revolves. With the exception of some little matters of detail, this plan is similar to others which have been proposed before.

(No. 2765, 10d.) John Henry Johnson, of 47, Lincoln's-Inn-fields, patents, as the agent of Charles Shaler Smith,





Charles Haslehurst Latrobe, and Frederick Henry Smith, of Baltimore, U.S., methods of constructing bridge piers of columns stiffened by a kind of shrouding of tension bars, diagonal ties being also provided to connect the heads of one set of columns with the feet of the next adjoining. The annexed sketch shows one arrangement proposed.

(No. 2798, 8d.) Jasper Henry Selwyn, of Woodland Crag, Grasmere, patents an ingeniously contrived entrenching tool for military use, this tool combining in one instrument a pick, a hoe, and a digging spade, whose blade and handle can be detached and used separately, the former as a breastplate and the latter as a pick, a walking staff, or for other purposes, such as assisting to support a "tente d'abri."

(No. 2800, 4d.) Jonathan Down, of Widnes, patents methods of obtaining copper from cupreous pyrites. These plans consist in neutralising the solutions of copper to such an extent as to retain the greater part of the arsenic, antimony, and other impurities in solution when the copper is precipitated from such solutions by metallic iron.

(No. 2803, 1s. 4d.) William Edwin Buckland, of Gloucester, patents methods of securing rails in railway chairs. According to some of these plans the rail is gripped by a "rolling wedge," this being a cam pivoted in a hollow in the jaw of the chair, and having a serrated edge which is eccentric to this hollow and which bears against the rail. In other cases the rail is held by a pair of wedges interposed between it and the jaw of the chair, the two wedges of each pair being arranged with their points towards each other and being drawn together, and thus tightened up, by a bolt passing through them. We fear that these wedges would be found difficult to keep tight.

SELENITIC MORTAR.

To the Editor of Engineering.

Sir,—Apropos of your account of Colonel Scott's selenitic mortar in your number for June 30th, the following information may be of interest. Allow me, however, first to point out an ambiguity in your report.

You speak of "sulphate of lime in the form of either plaster-of-paris, gypsum, or green vitriol." Now green vitriol is a sulphate of iron, and not a sulphate of lime, as the above sentence would imply.

Further on you say that "Colonel Scott uses sulphuric acid in preference to plaster-of-paris," meaning, I believe, "green vitriol in preference to plaster-of-paris." Is it not so?

To resume. Two years ago I saw in Calcutta some steps leading to a public office which struck my attention. There was a great deal of traffic over them, they had been in use about fifteen years, and they were scarcely worn. The surface was beautifully polished and appeared like a kind of hard porphyry. On inquiry I ascertained that they were made of Portland cement mixed with a small quantity of green vitriol. This fully confirms the statements of your report as to the strength and fineness of surface imparted by the addition of the sulphate; but if Colonel Scott has taken a patent, I fear such a public use for fifteen years will somewhat damage its validity.

Struck with the excellence of these steps, I made several experiments with various limes and with Portland cement, and subsequently, used selenitic mortar on more than one occasion. I never tried the substitution of plaster-of-paris, and am quite prepared to hear that it is very inferior to green vitriol. Your theory of the effect of the sulphate I cannot quite understand. The lime I used was thoroughly "slaked." The action of the sulphate appears to me to be thus:

$$\left.\begin{matrix}\text{Sulphate of iron}\\ \text{Lime}\end{matrix}\right\} \text{become} \left\{\begin{matrix}\text{Sulphate of lime.}\\ \text{Oxide of iron.}\end{matrix}\right.$$

Both the substances produced, viz.:—sulphate of lime (plaster-of-paris) and oxide of iron (rust), are themselves powerful cements and hard substances, and naturally increase the strength and hardness of the mortar with which they are intimately combined.

I am, Sir, your obedient Servant,

C. E.

Bankipore, Bengal, August 27, 1871.

REGISTERING WEIGHING MACHINE.

DESIGNED BY MR. HENRY FAIRBANKS, ST. JOHNSBURY, VERMONT, U.S.A.

FIG. 1.

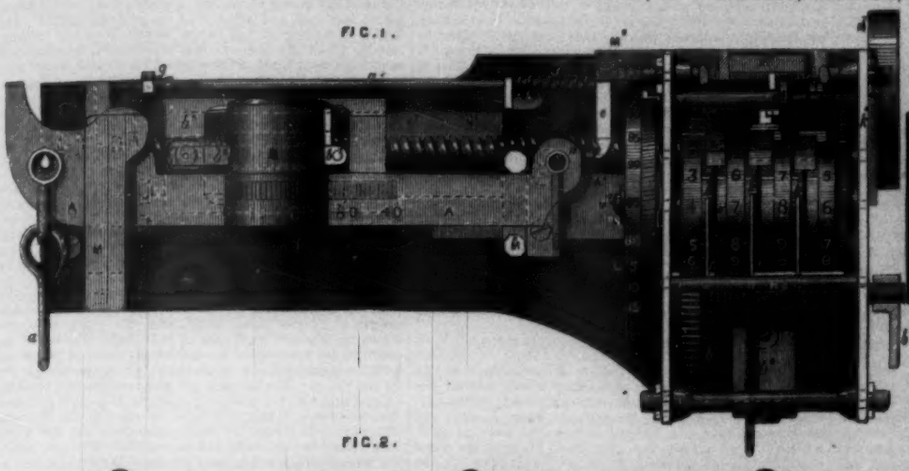


FIG. 3.

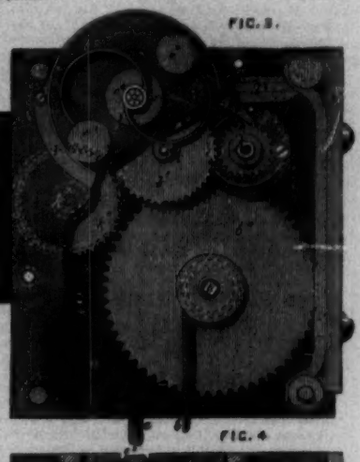


FIG. 2.

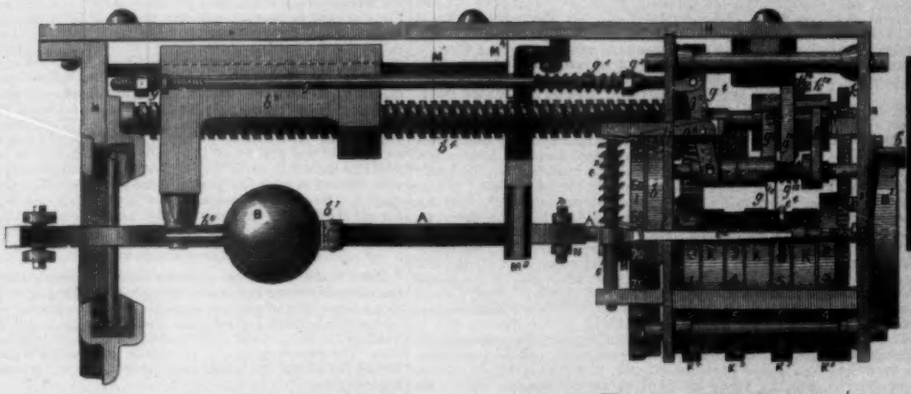


FIG. 4

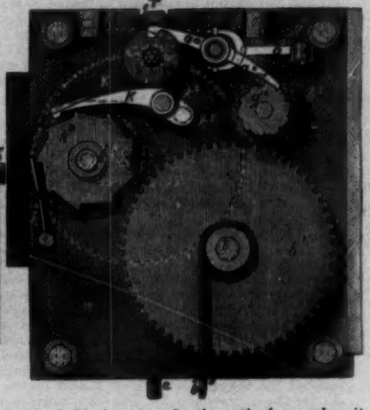
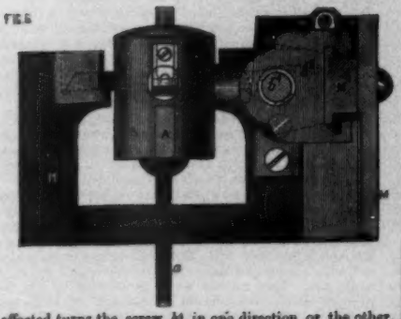


FIG 5



MANY weighing machines have been made for insuring absolute or approximate uniformity in the quantities weighed at each operation, and such machines are very useful in weighing grain and analogous mobile or fluid material; but they are obviously unsuited for weighing irregular quantities of solid substances. We, however, give above engravings of an ingenious machine designed and recently patented by Mr. Henry Fairbanks, of St. Johnsbury, Vermont, U.S.A., which weighs and indicates correctly widely varying weights, although it is best adapted to weigh masses which are approximately uniform, such as successive wheelbarrow loads, wagon loads, or car loads of coal, metals, ores, stone, ice, or the like. It requires no inspection or mental operations on the part of the attendant, who may operate successfully after a little practice, even if unable to read, or without light, or under circumstances where the fingers are cold and numb.

It has long been common to register or indicate plainly to the eye the number of revolutions of a steam engine, and various analogous matters by means of figures on wheels mounted side by side, and so connected together by other mechanism that the motion given to the units wheel imparts the proper slower intermittent motion to the tens wheel, and this again to the hundreds wheel, and so on indefinitely. Mr. Fairbanks has combined such a mechanism with a weighing scale, and has provided means whereby the operation of weighing and registering is mainly automatic, and the machine may be worked successfully and reliably by very ignorant and unskilled workmen. In our engravings Fig. 1 is a front view of this machine; Fig. 2 is a plan; Fig. 3 is an end view with a part of the end plate broken away to show the mechanism; Fig. 4 is a cross section through the registering mechanism; and Fig. 5 is a cross section through the beam, the screw which transmits motion to the poise, the guide of the poise mover, and the frame.

Referring to these figures, A is the beam of a platform or other scale of ordinary or suitable construction. It has not been considered necessary to represent the platform, the supporting levers, and other ordinary mechanism by which the weight of the load is transmitted to the important member termed the weighing beam. The rod by which the force is made to move the beam, A, is indicated by *a*. We shall indicate the framework wherever necessary by the letter M, and any special member of the framework by M^1, M^2, &c. A guide, M^1, is provided on the framework to steady the motions of the poise slider, and stops, M^2, M^3, are provided to limit the extent of the vibrations of the beam, A. B is the poise; it is slid outward or to the right on the beam, A, by turning the hand crank, *b*, in one direction, and is moved inward or to the left on the beam by turning the same hand crank, *b*, in the opposite direction. The train of mechanism, *b*, b^1, b^2, to b^7, and b^8, by which this is effected turns the screw, b^4, in one direction or the other, and thus correspondingly moves the poise slider, b^5, and through the medium of the light rod, b^6, which makes a connexion with the poise at the point, b^7, pushes out or draws in the poise on the beam, A. The parts in the train of connecting mechanism are the shaft, b^1, carrying a gear wheel, b^2, meshing into another gear wheel, b^3, fixed upon a continuation of the endless screw, b^4. Mr. Fairbanks prefers that the upper edge of the beam, A, shall be perfectly smooth. The ordinary graduations may be made on the broad front face of the beam, and the machine may be used for weighing in the ordinary manner by simply disconnecting the other work if it should ever become necessary.

We shall describe the action of the machine by directing the attention successively to the several parts in each train of mechanism which performs an important function; and we shall premise generally that the hand crank, *b*, turns successively in opposite directions; it is turned by the hand to the right until the poise is slid back, or to the left on the beam, A, to the zero point; now it is stopped forcibly by means which will be described further on, and next the crank, *b*, is turned in the reverse direction, either by the hand of the attendant or by the action of a spring, or of a weight pulling on a cord wound upon the axis, b^1, and this motion revolves the screw, b^4, in such direction as to traverse the poise, B, slowly to the right.

We will now describe the action of another train of mechanism which stops this reverse motion of the crank, *b*, when the poise has been moved out to exactly the proper extent, and the correct weight ascertained. There is a bell-crank lever hung above upon a shaft, c^1, fixed in arms, M^4, forming a part of the fixed framework, M. The vertical or hanging arm of this lever, as also the entire lever, when it becomes necessary to refer to it is denominated *c*, and stands with its lower extremity close to the nicely finished steel extension piece, A^1, of the beam, A. There is a coiled spring, c^2, coiled around the shaft, c^1, and tending to press the arm, *c*, towards the beam, A, and consequently to depress the horizontal arm, c^3. So long as the beam, A, is in its highest position the arm, *c*, presses lightly at intervals against the end of the extension, A^1, and the arm, c^3, is thereby supported, while a notch, c^4, in the wheel, c^4, to be described below, is passing and prevented from dropping into the notch, except to a very small extent, from which it is immediately lifted out again by the bevelled form of the notch; but when the beam, A, sinks by reason of the poise, B, having been slid outward until the proper weight is ascertained, then the extension piece, A^1, of the beam, A, is carried below the end of the hanging arm, *c*, and leaves the bell-crank lever, c^2, free the next time the notch, c^5, is presented to turn by its gravity, and by the action of the spring, c^2, to depress the arm, c^3, deeply into the same notch, and thereby stop the wheel.

The wheel, c^4, forms a part of another train of mechanism to be described below; it is revolved rapidly, while the poise, B, is being moved slowly outward, and its notch, c^5, is adapted to receive the horizontal arm, c^3, of the lever before described whenever such lever is allowed to sink. So soon as the beam, A, is sunk out of contact with the arm, *c*, the lever, c^2, drops into the notch, c^5, and arrests the motion of this wheel, and consequently of the entire connected train of mechanism. This function cannot be fully understood until the other trains of mechanism and their relations thereto are explained, but having now described the immediate and direct effect of the sinking of the beam, A, to drop the lever, c^2, into the notch, c^5 (and thus by arresting the quickly moving wheel, c^4, to arrest the hand of the operator and the entire train of mechanism, b^1 to b^7). We will describe what takes place on the reverse movement, and will afterwards explain how the movement of the machinery in the one direction registers the weights of the successive loads.

The attendant, so soon as the load to be weighed is fairly placed on the platform (not represented) so that its weight is properly transmitted through the rod, *a*, to the beam, A, seizes the crank, *b*, and turns it to the right, and thus turns the endless screw, b^4, in the direction which moves the poise, B, inward (to the left). As it approaches the zero mark the poise slider, b^5, strikes a nut, *g*, which is adjustable on a rod, g^1, so supported that it may move endwise to a limited extent. It is pressed to the right by a coiled spring, g^2, acting between the supporting bracket, M^4, and an adjustable nut, g^3, and is connected by the pivot, g^4, to a lever, g^5, pivoted on the fixed framework at the point, g^6, and having

a forked arm, g^7, at the opposite extremity, the function of which will presently appear.

Now when the poise slider, b^4, strikes the nut, g, and moves the rod, g^1, to the left, the parts are so adjusted that just as the poise, B, has reached the zero mark on the beam, A, the rod, g^1, has been moved so far to the left that it rocks the lever, g^4, g^6, g^7, and moves the end, g^7, to the right. The forked arm, g^7, takes hold of pins, g^8, on a sleeve, g^9, which is capable of sliding endwise, as also of turning to a limited extent on a smooth cylindrical rod, M^4. This sleeve, g^9, carries two nearly opposite arms, the one, g^{10}, extending forward under the lever, e^3, before described, the other, g^{11}, extends backward, and fulfils the important function of arresting the motion of the entire mechanism so soon as the sleeve, g^9, is moved endwise to the right, as before described. This is accomplished as follows: There is a broad ratchet wheel, g^{12}, on the extended shaft of the endless screw, b^2. The pawl, g^{11}, catches in this ratchet, g^{12}, whenever it is depressed. This pawl, g^{11}, remains elevated, and the screw, b^2, may turn freely until the end motion of the sleeve, g^9, and its connexions is completed to the right. This end motion carries the arm, g^{11}, under a pin, g^{13}, which is fixed in the wheel, g^{14}, carried on the extension of the shaft, b^4. The parts are so arranged that the end motion of the sleeve carries the pawl, g^{11}, into the path of the pin, g^{13}, and at the next revolution the pin, g^{13}, strikes on the upper side of the pawl arm, g^{11}, and presses it down into the ratchet, g^{12}.

It follows from this that the backward motion of the hand crank, b, and its connexions to traverse back the poise, B, is arrested by the forcing down of the pawl, g^{11}, into the ratchet, g^{12}, so soon as the poise, D, has reached the zero mark on the scale, A. It will now be understood that the attendant has simply to turn the crank, b, to the right until it stops, and then to turn it to the left, or in the reverse direction, (or allow it to be turned to the left by the action of an attached weight and cord), until it is again stopped, and that this completes the weighing operation so far as the action of the attendant is concerned. We will presently describe the action of the registering mechanism which takes place in the interim. It will be understood that the cord and its weight may be used as a substitute for hand power in inducing the reverse motion.

The weight may be enclosed in a suitable casing or well if necessary to protect it from disturbing influences. With this pulley and weight it is not necessary that the attendant shall turn the crank except in the forward direction, but he turns it forward until it stops and then liberates it, and it then turns slowly backward by the action of the weight acting through the cord, b^6, and thereby transmitting its motion to the shaft, b^4, and its connexions. Where such weight and cord are not used it is necessary that the attendant shall retain his hold on the crank, b, and shall turn it slowly backward until it is stopped. In either case it is not essential to success that a special attendant be stationed at the scale. The labourers who operate the wheelbarrows, or who drive the wagons or brake, or otherwise attend on the cars or other mediums by which the loads are successively transported to and from the scale, may each in succession, when properly instructed, operate the scale in the simple manner required. A sleeve, k, is mounted loosely on the extended shaft of the endless screw, b^4. This sleeve carries a ratchet, k^1, which receives a pawl, k^2, hung on the rod, M^3, before described. This pawl prevents the ratchet, k^1, and its connexions revolving excepting in one direction, that is during the motion of the poise, B, outward. During this motion the sleeve, k, is turned with the screw, b^4, by means of a pawl, k^{14}, hung by the pin, k^{15}, on the wheel, g^{12}. There is a gear wheel, k^3, fixed on the sleeve, k, and which gears into a larger wheel, k^4, on a cranked shaft, k^5. The crank, k^5, on this shaft, k^6, is peculiarly constructed. It is strong and of sufficient length to carry three pawls, K, K, K, adapted to work corresponding register wheels. The register wheels are mounted on a shaft, k^7, and are denoted successively, K^1, K^2, K^3, K^4. The units wheel, K^1, is attached firmly to a gear wheel, k^8, which meshes into the gear wheel, k^4, before described. Every revolution of the cranked shaft, k^5, gives a corresponding revolution to the units wheel, K^1.

The wheels for the tens, hundreds, &c., are worked entirely by pawls from the crank, k^5. The pawl, K, takes in notches, k^9, on the right-hand face of the tens wheel. There are corresponding notches, or in short a ratchet wheel fixed on the right-hand side of the wheel for hundreds, for thousands, and for as many more wheels as may be used. The pawl, K, catches a tooth of the ratchet, k^9, at each revolution of the crank, k^5; but the pawl, K, does not catch in the ratchet on the hundreds wheel, except once for each revolution of the tens wheel. The action in this respect is probably analogous to that of many registering wheels before known. After ten revolutions of the crank, k^5, a recess, k^{10}, on the left-hand side of the tens wheel allows the next pawl, K, to sink low enough to take one of the teeth of the ratchet, k^9, in the hundreds wheel and thus to move that one notch and present a new number. After a complete revolution of the hundreds wheel a corresponding notch, k^{10}, on the left-hand side of this wheel allows the next pawl, K, to descend and to act on one tooth of the ratchet, k^9, on the thousands wheel. It follows that the figures imprinted, embossed, or otherwise made visible on the units, tens, hundreds, and thousands wheels are rotated properly to indicate to the eye in the front line of figures the aggregate number of pounds weighed during and at the close of a long series of successive weighing operations. A cross bar or other suitable aid may be employed to assist the eye in reading the numbers across properly. These figures may be raised and a suitable strip of paper being drawn across the figures may be imprinted on the paper by a properly administered blow of a suitable hammer or other appropriate mechanism, either at the close of the operation or after each successive weighing if preferred.

Mr. Fairbanks has in another machine designed by him included mechanism for printing the weights on a strip of paper. The two modes of indicating the weights may be useful as a check upon each other as a safeguard against experiencing any serious results from mistake or derangement in the action of any part.

We have now explained how the motion of the poise slider to the left draws the rod, g^1, to the left, and moves the sleeve, g^9, and its connexions to the right, to effect the automatic stopping of the crank, b, and its connexions so soon as the poise has reached the zero mark. But we have not described the means whereby this sleeve, g^9, is returned and slid back to its original position when the poise slider, b^4, commences again to move onwards (to the right). This is partly due to the action of the spiral spring, g^{15}, which urges the rod, g^1, to the right so soon as it is liberated, and is due partly to the coiled spring, g^{16}, not before described, which acts directly against the sleeve, g^9, pressing it to the left out of the path of the pin, g^{13}. It will be seen that the connexion of the forked end, g^7, of the lever, g^4, to the pins, g^8, and the sleeve, g^9, is made through the medium of slots, so that the sleeve, g^9, may turn freely to a limited extent around the pin or guide, M^4. Mr. Fairbanks states that he has found in practice that it is better to allow a still freer tilting motion to the pawl, g^{11}, and to the opposite arm, g^{10}, and he consequently divides what for shortness he denominates the sleeve, g^9, into two parts, making the right-hand part perfectly free to turn; it rocks freely to any required extent on the smooth guide rod, M^3, and its contact with the other parts of the sleeve, g^9, and with the spring, g^{15}, only affects its endwise position.

We have described that the lever, e^3, sinks into a notch, e^5, in a quickly-rotating wheel, e^4, fixed on a shaft, e^2, and that it thereby serves to arrest the motion of the crank, b, and its connexions, including the registering wheels and all the other parts of the mechanism when the poise is moved outward to the proper extent, so that the beam, A, sinks and liberates the lever, e^3. The engravings show how this quick motion is received from the gear wheel, k^4, upon the crank shaft, k^5, through the small pinion, e^1, which gears into the gear wheel, k^4, before described. Mr. Fairbanks esteems it an important point in his machine that e^5 rides on the wheel, e^4, during most of its rotation, and consequently that the hanging arm, e, does not touch A^1 except at intervals. This makes an intermittent or feeling contact, and the beam, A, is perfectly free to rise and sink without any friction therefrom during the intervals. The wheel, e^4, may have several notches instead of one, as here represented. Mr. Fairbanks states that he has experimented successfully with five, and that for some reasons he prefers that number of notches, but the wheel may have any number of notches. Mr. Fairbanks prefers one notch for each figure on the units wheel. Whatever the number of notches, e^5, in this wheel, e^4, there is a function performed by the arm, g^{10}, in lifting the lever, e^3, out of the notch the moment the opposite arm or pawl, g^{11}, is depressed by the pin, g^{13}, as before described. That action raises the arm, g^{10}, and consequently the lever, e^3, the moment the rod, g^1, is pressed to the left. It is by this means that the hanging arm, e, is moved outward beyond the end of the beam, A, and its extension, A^1, at the commencement of each weighing operation.

We have not yet described the provision for governing the motion of the quickly-moving wheel, e^4, and its connexions. This is done by means of a pair of curved and highly elastic arms, e^6, which are fixed on the overhanging end of the shaft, e^2, and carry weights, e^7, which traverse in close proximity to the smooth interior of the cylindrical fixed band, M^7. When the velocity of the shaft tends to exceed the proper amount the centrifugal force of the weights, e^7, extends the curved arms, e^6, and generates sufficient friction between the weights, e^7, and the interior of the ring, M^7, to retard the motion.

We must now describe how the registering wheels, K^2, K^3, &c., are held against any accidental backward movements as the pawls, K, slip over them. This is effected by means of the springs, K^{11}, which are fixed on a bar, M^5, and press on the respective ratchet wheels as represented.

The mechanism now described registers the aggregate weight; but it is obviously convenient to know not only that, but also the aggregate number of successive weighings; this is indicated by the wheel, L, which is mounted on a stud, M^6, and is provided with five graduations on its periphery, and with a correspondingly fine ratchet wheel on its right-hand side. This ratchet wheel is worked by the hooked pawl, l^1, which is connected by the pin, l^2, to an arm, l^3, fixed upon the lever, g^5, before described. At each end movement of the rod, g^1, the arm, l^3, is moved in one direction or the other, and the hooked pawl, l^1, at each round of operations of the machine, moves the wheel, L, one graduation, indicating that one more load has been weighed. By turning the nut, g, and thus changing its position on the rod, g^1, the point is changed at which the poise, B, stands on the beam when its backward motion is arrested, and although, however, this may be adjusted, the beam, A, will always sink when the poise has been moved outward to the right weight it will be observed that the machine only registers the amount of the motion outward to that point from the fixed point, whether zero or any other point, from which it commenced its outward movement. It will be seen, therefore, that by adjusting the nut, g, in various positions on the rod, g^1, the point at which the poise is arrested and commences to move outward may be varied within wide limits. By this means the machine can be adjusted to allow for increased weight of platform or any other cause due to repairs or the like, or "tare" can be allowed for by adjusting the said nut to allow for the weight of the heavy wagon or the like in which the load may be carried.

Mr. Fairbanks' scale is also adapted for the addition of separate poises to balance any permanent weight, as the weight of a wagon. This is done by attaching the weights in any ordinary and suitable manner to the link, N, which is suspended to the knife edge, n, near the outer (or right-hand) end of the beam, A. This is, in short, a counterweight, and it performs all the functions of a counterweight in the machine. Mr. Fairbanks allows for it by adding a corresponding amount for each time the weighing is effected, ascertained by means of the counter-wheel, L, or otherwise.

Ordinarily the works of the machine will not be made accessible to the attendant or workman. The proprietor or superintendent adjusts the scale and locks up the casing of the machine, and at the end of the day's work, or at any other period, he observes and records the amount registered. The facing of the casing should be of plate glass or other transparent material, and adapted to be properly lighted. For facility of reading it will be well to provide a bar or other suitable guide for the eye, not represented, which should extend across in front of the register wheels and out of contact therewith. At the end of a succession of weighings, or at any other time when it is necessary, the case may be opened and all the wheels set back or rather forward to zero to commence a new series of weighing operations.

Mr. Fairbanks' mechanism guards effectually against the serious derangement which might result from an accidental irregularity on the part of the workmen in turning the crank, b. It will be observed that when a weighing has been effected, and a new load placed on the platform, the crank, b, is capable of being turned only in one direction, that required to move the poise, B, inward (to the left); this condition obtains throughout the entire inward movement of the poise. It is never possible to move the poise outward by turning the crank, b, in the opposite direction until it has been moved inward to the full and proper extent; this results from the action of the pawl, k^{14}, in the ratchet, k^3, which is connected by the parts, k^3, k^4, with the quick wheel, e^4, which the lever, e^3, continues to hold fast. But when the poise, B, has been moved inward to the full and proper extent the pressing down of the pawl, g^{11}, in the ratchet, g^{12}, by the pin, g^{13}, lifts the arm, g^{10}, and consequently the arm, e^3, and then and not before the machine is in such condition that the crank, b, may be turned in the opposite direction. Now it may be turned in the opposite direction, that which moves the poise outward, and only in that direction. After the attendant has commenced to turn it in that direction so that the poise is moving out, the motion of the crank, b, cannot be again reversed until it has been moved out to the full extent and the beam, A, has dropped; this results from the action of the pawl, g^{11}, on the ratchet, g^{12}, which is firmly connected to the screw, b^4. Any attempt to reverse the motion of the crank is effectually arrested by this pawl and its connexions until the poise has been moved outward to the proper extent, and the beam, A, has sunk. The sinking of the beam, A, liberates the arm, e, and consequently the arm, e^3, and the gravity of this arm, e^3, is sufficient, as it falls into the notch, e^4, in the quick wheel, e^4, to depress the arm, g^{10}, and to raise the pawl, g^{11}, out of contact with the ratchet. These provisions are very important in avoiding the mischief which might otherwise result from careless, fraudulent, or mischievous irregularity in turning the crank, b.

ROUMELIAN RAILWAYS.—Advices from Adrianople state that the railway works are proceeding without flagging, and that a large body of men are engaged in the construction of earthworks between Dedé-Agatch and Philippopoli, and in building the stations and other necessary buildings along the line. The inspectors hope to be able to continue the works during the winter, but in this anticipation they are, perhaps, too sanguine.

LONDON AND NORTH-WESTERN RAILWAY.—The directors of the London and North-Western Railway gave a dinner at the Euston Hotel, on Friday, to Mr. John Ramsbottom, chief mechanical engineer of the company, on the occasion of his retirement from the active duties of the official position he has occupied in connexion with this corporation during the last 20 years. Mr. Moon presided, and among those who attended to do honour to Mr. Ramsbottom were the Duke of Buckingham, Sir Joseph Whitworth, the Lord Mayor of London, Mr. C. F. Beyer, of Manchester, &c. About forty gentlemen sat down. After dinner Mr. Moon, in proposing "The health of Mr. Ramsbottom," alluded to the very valuable services that gentleman had rendered to the London and North-Western Railway during his long association with the company, and bore testimony to the large saving effected by him in the working of the locomotive department as well as by the application of his various mechanical inventions, all tending to improve and facilitate travelling on railways. As an illustration of the improvement effected by Mr. Ramsbottom, it was stated when that gentleman took the control of the company's works at Crewe a pair of engine or carriage wheels actually travelled a distance of seven miles from shop to shop in the process of completion, while at the present date, owing to the concentrative economy introduced into the mode of manufacture by Mr. Ramsbottom, the same pair of wheels were completed within a space covered by seven yards. Mr. Ramsbottom, replying, regretted that the present state of his health had compelled him to retire from a position he had had the honour to hold for many years. Alluding to his humble beginning in the company's service, he acknowledged the progressive advantages which had rewarded the application of his abilities to the interests of the company, which he could truthfully say had with himself always been a labour of love. Mr. Chance, a director, and chairman of the locomotive committee, confirmed all the chairman had said on the subject of the savings effected by Mr. Ramsbottom, and congratulated his brother directors upon the fact that the London and North-Western Railway were not about to lose altogether the benefit of Mr. Ramsbottom's co-operation. That gentleman's great ability and mechanical genius would under arrangement be still at the disposal of the company in any important matter that might be referred to his consideration, and the board of directory had that day voted a sum of money which it was intended should take the form of some permanent acknowledgment of Mr. Ramsbottom's past services. The Lord Mayor proposed "The health of the Chairman and Board of Directors of the London and North-Western Railway Company," which was responded to by Mr. Moon, with whose remarks the proceedings of a most agreeable evening terminated.—*Standard.*

THE TRIESTE EXHIBITION.

TRIESTE, September 29.

THE first exhibition of arts and manufactures is now opened here, under the most favourable auspices that could be expected from the maiden essay of a committee composed of the principal bankers, merchants, manufacturers, and tradesmen of the city, who all have appeared to labour with a zeal and energy worthy of the undertaking. Taken altogether, the result cannot but be gratifying to this committee, as it is pleasing and most instructive to the people of the towns and country adjacent, and though only intended for the display of local productions in all branches of industrial and useful arts, including both painting and sculpture, the Trieste Exhibition would compare favourably in its small way with others of larger and more exalted pretensions in its power of creating and encouraging a desire on the part of its supporters to extend its usefulness and scope by, on future occasions, so expanding it as to open it for the admission of works from foreign countries, and in so doing to still further improve the opportunities of each, as it is by a comparison of collective skill that improvements are secured and an extension of trade and commerce is accelerated.

It would be impossible to extol too highly the naval specimens of ship and boat building, models of ancient and modern ships, lighthouse appliances, anchors, chain cables, and other miscellaneous productions of a naval dockyard, which have been placed at the service of the commissioners by the Kaiserin Government; they are simply perfect in workmanship, containing all the elements of usefulness without ornament.

The exhibition of metallurgical specimens is also a speciality of Austria, and at the Trieste Exhibition there is an admirable collection, showing materials and products, and including a series of samples from the different ores and oxides to the finished forms of metal; while besides these are specimens illustrating the great ductibility and strength of the iron of Austria. The examples of copper ores and working are instructive and worthy of close study and examination, as are also those of tin and zinc working; there is besides an extensive collection of plumbago crucibles for metal smelting of great size and apparently of very good workmanship.

The section of agriculture is poor and meagre in the extreme, and should the next Trieste Exhibition be universal, our English manufacturers will, we should imagine, find a profitable field in this section for examples of their skill, invention, and workmanship, more especially of agricultural and road engines, and irrigation and pumping machinery. The present exhibition contains nothing of the latter kind with the exception of a few poor models of the local systems of well sinking and raising water.

The pottery and pavement manufacture of Trieste is worthy of some attention and improvement. The puzzalano is a wonderful material for density and hardness. It can be cast into any form as walls, flooring, columns, cornices, ornaments, trusses, and articles of daily use, and can also be turned to account for engine beds, foundations, piers, moles, baths, closets, and drain pipes; indeed the variety of form which can be given to this material is endless. Of brick and tile machinery there is none in the Trieste Exhibition, and here also is another opening for the more perfect models of our English manufacturers. Telegraphy is unrepresented, although a collection of telegraphic appliances would have been a most valuable exhibit in a country where locally and provincially electric communication is esteemed of such value by the Government for public and mercantile purposes.

There being no open fireplaces in Austria in consequence of the comparative absence of coal and the use of wood fuel, the huge upright porcelain stoves, fed from the outside of the room in which they are placed, form a feature in the exhibition under notice. Some of these stoves include ornamental features and are very handsome, inclining, however, towards the mural Kensal-green form; they are, notwithstanding, good and effective, causing no dust or ashes; and are in some respects worthy of imitation in our own country as they can be fed with either wood, coal, or coke. The exhibition includes but one marble chimney-piece, probably placed as a contrast to the more favourable Austrian and Italian examples. There are several models of Austrian kitchen ranges, which ranges, by the way, are always placed in the middle of the room, and are very convenient.

The specimens of timber are fewer and smaller than might have been expected from the immense timber forests in possession of the Austrian Government. The examples of furniture are of the ordinary kind, and though elegant and ornamental, are fragile, the substantiality of our English work being wanting. Soap and candle manufactures are a Trieste speciality, and their products are exhibited in numerous forms, qualities, and prices, but household necessities hardly require a Cupid in wax, or the Apollo Belvidere in stearine soap. Carpets in Turkish and Continental designs are of the usual unalterable form, design, and manufacture, and are not good.

There are several systems of bath-rooms and closet arrangements exhibited, but much that is good of this kind could hardly be expected from Italian cities, in which such improvements are so desirable, for anything more execrable than the sanitary arrangements of Italian houses even of the best class cannot be imagined. Here again, if the many more perfect models of English manufacture could be introduced, a vast improvement would be effected; but vile smells are hardly considered an abomination, or dangerous to health in this and other neighbouring cities.

The horological portion of the exhibition is a very important section occupying one end of the principal nave of the main building; the clocks and watches are excellent in design and workmanship, apparently, while their cheapness is marvellous. There is, of course, the usual exhibition of wonderful singing birds and trumpeters of the hour, so much admired by the Continental rurals, while some of the large standard clocks are works of art in cabinetry.

There are no artillery or gunnery exhibits; there not being a carriage or limber or single form of shot or shell to be seen. The Austrian Government keep these things very closely, and presume that they are matters upon which the general population need hardly be instructed or know anything about, and in this they are perhaps right. The sporting guns, and others of offence and defence, are as remarkably poor as the Continentals are, as a rule, in the art of *la chasse*. Saddlery is omitted, the Italians not being horsemen; but harness is perfect in many respects and is a cheap production in this country, owing to the perfection of hides and the mode of tanning, while leather work in every form is a principal branch of industry of its people. Sword cutlery and accoutrements form a small section. Photography, millinery, hair-dressing, printing cards and tickets, and other minor arts have each their place and are ably represented. The picture gallery is well filled with Austrian and Italian art in painting and sculpture; the emperor having kindly placed at the disposal of the commissioners many fine pictures from his own gallery.

The building is temporary, constructed of wood in the form of a cross, well lighted from the upper sides; while the different annexes are placed about the grounds in convenient position, one containing an agricultural display while the other is devoted to carriages, &c.

The admission was at first an Austrian florin of nearly two shillings, but is now reduced to fifty soldis or eleven pence of English money. The town of Trieste expected great results in the way of visitors, but has been very much disappointed, as rumours of the anticipated rapacity of householders reached the country districts, and they appear to have come to a general resolve to disappoint the wolfish expectations of their Triestine friends. The hotels have been asking 10 florins a bed = 18s. 4d. per day.

RAILWAYS AT THE CAPE.—A railway is to be commenced in the eastern province, and the Governor has been authorised to negotiate with the Cape Town and Wellington Company for the purchase of their line, the proposed terms of purchase to be submitted to Parliament in its next session.

SWISS MECHANICAL INDUSTRY.—Switzerland is about to have a large and well organised locomotive factory. For this purpose, an influential company of Swiss bankers has recently been formed with a capital of 120,000*l.*, at Winterthur; a town widely known for its flourishing commerce and industry. We understand that the new engine works at Winterthur will be laid out for an annual production of fifty locomotives, comprising as a speciality the construction of mountain locomotives. The works will be under the superintendence of Mr. Charles Brown, up to the present the technical manager at Messrs. Sulzer's of that town; a firm who enjoy a high reputation on the Continent as very successful steam engine builders.

LITERATURE.

The Road-master's Assistant and Section-master's Guide; a Manual of Reference for all having to do with the Permanent Way American Railroads, and containing the best results of experience and minute directions for Track Laying, Ballasting, and Keeping the Track in Good Repair. By WILLIAM S. HUNTINGTON. *Railroad Gazette* Series. Chicago: *A. N. Kellogg.*

ALTHOUGH nominally written expressly for the use of American railway men, Mr. Huntington's little manual possesses a usefulness which will be appreciated in many places besides the United States. At the present time, when railway construction is rapidly progressing in our colonies, and in numerous thinly-populated districts where it is necessary to resort to systems of construction more or less resembling those largely used in America, the work possesses a special value, and it deserves to be widely known and circulated. Mr. Huntington is evidently thoroughly acquainted with the subject on which he writes, and he gives the results of his experience in clear, straightforward language, advancing no doubtful theories, but explaining fully and ably the practical points to which it is necessary to attend in laying and maintaining permanent way, and never hesitating to expose the faults and abuses which but too frequently exist.

We are sorely tempted to give numerous quotations from Mr. Huntington's manual; but we resist the temptation, as, if we once began quoting, it is difficult to say where we should end, and we shall therefore content ourselves by laying before our readers a general synopsis of the contents of the book. The first chapter, then, deals with track-laying, and includes notes on the general practical points to be observed, and much useful information concerning cross-ties (*Anglice*, "sleepers"), laying cross-ties on bridges, trestle work, the use of "shims," &c. Our author is very vigorous in his condemnation of bad work, and he is careful to point out the salient features by which bad work is characterised, and to explain how work of good quality can be secured. Chapter II. treats of laying the rails, and here we find instructions relating to curving iron, laying rails on curves, replacing rails, &c., particular attention being directed to the necessity of making due provision for expansion and contraction—a much more important matter in the United States than here owing to the greater variation of temperature. Methods of preventing and remedying "creeping track" are also dealt with briefly.

The next chapter is headed "About Spikes," and, although short—as, indeed, are all the chapters—it contains a vast number of useful hints. Here we find Mr. Huntington again condemning careless work, and pointing out the great waste which carelessness involves. The fourth chapter deals with cattle guards, culverts, and turn-outs, and is as good as the preceding ones. As a specimen of Mr. Huntington's style of treating the subject, we may yield to temptation and quote from this chapter a few of his remarks on guard rails. He says:

> The guard rail, placed opposite the frog,* is frequently too short, and the bend at the ends too abrupt. When guard rails are made of common track rails they should be of good length, and the bend much further from the end than is usual. A short guard rail, with its ends bent nearly at right angles, is an abomination. . . . Placing a guard rail properly is a much nicer operation than is generally supposed. It is amusing to see a man, in spiking a guard rail, use his hammer to measure the distance the guard is to be from the main rail. If he can drop his hammer in lengthwise, between the main rail and the guard, it is supposed to be right, no matter what the size of the hammer. . . . To place a guard rail properly it is a good plan to measure 2 in. from the end of the gauge, and make a mark there. Then place the opposite end of the gauge at the point of the frog, and spike the guard rail to this mark, always measuring from the point of the frog, and not from the rail opposite. This will answer as a general rule, yet there are some peculiar cases to which it would not apply so well.

Chapter V. treats of ballasting, and Mr. Huntington's remarks on this subject, and especially his instructions for raising the track, tamping, dressing off, &c., will be useful in English as well as American practice. Mr. Huntington is a firm advocate for good ballasting, and if all American engineers viewed the matter in the same light it would be to the advantage of the proprietors of the roads and of those who travel over them. Next we have four excellent chapters treating of general repairs of line, drawing spikes, "shimming"—or packing rails with wood "shims" inter-

* In the United States the term "frog" is applied to crossings.

posed between them and the sleepers—a practice much resorted to in winter when the sleepers cannot be tamped on account of the frost—repairing switches, &c., renewing sleepers and rails, and other similar matters, all of which are dealt with in a thoroughly practical way. Chapter X. treats of snow and ice, and includes some pertinent remarks concerning the manner in which locomotive superintendents neglect the improvement of snow ploughs; Chapter XI. is headed "A word to superintendents and road-masters," and contains some sensible advice concerning personal duties; Chapter XII. treats of "fire and water as enemies," and contains also hints about preserving fences; while Chapter XIII. and last deals with railway accidents, and contains a straightforward and just denunciation of false economy in railway construction. Such, then, are the contents of Mr. Huntington's little manual—"little" as far as lineal dimensions go, but great in its capacity for conveying useful practical information. The book is a thoroughly good one, and we trust that it may have a large circulation amongst the class for whom it has been written.

Light Science for Leisure Hours. A Series of Familiar Essays on Scientific Subjects, Natural Phenomena, &c. By Richard A. Proctor, B.A. Camb., F.R.A.S. Author of "The Sun," "Other Worlds than Ours," "Saturn," &c. London: Longmans, Green, and Co.

The art of writing familiar essays which, while free from abstruse technicalities, shall yet convey really sound and accurate information on scientific subjects, is one possessed by but few. Mr. Procter, however, *is* one of those few, and his writings possess a proportional value. Dozens of books are published professing to treat of one or the other department of science from a popular point of view; but it is rarely that such works convey information of real value, for the reason that they are but too frequently written by mere smatterers in science who have no really sound information to convey. To such books, the collection of essays before us forms a most pleasing contrast. Mr. Procter has a most graphic pen, and his descriptions of the great phenomena of nature are admirable examples of "word painting;" but however brilliant the colouring may be the truth of outline is never neglected, our author being evidently far too faithful a lover of scientific accuracy to sacrifice it for the sake of gaining an effect.

The essays under notice—which we may remark have been selected from articles contributed by Mr. Procter to the *Daily News*, the *Cornhill Magazine*, *St. Pauls*, &c.—relate to a wide range of subjects. The phenomena of the aurora borealis, terrestial magnetism, the transit of Venus in 1874, recent solar researches, the great problems of physical geography, earthquakes and volcanic eruptions, deep sea dredging, the Oxford and Cambridge rowing styles, the philosophy of betting, and many other matters which we cannot enumerate here, are all dealt with in a manner which affords ample evidence of the knowledge and careful research which the author brings to bear upon his task, and of his powers as a writer. "Light Science for Leisure Hours" is not a book which we need review in detail, but it is one which we can most heartily recommend. It is the work of an earnest thinker, and thinkers who read it will be delighted with the broad views which the author explains so clearly and supports so ably; while readers of a more superficial class will be equally pleased with the descriptions which Mr. Procter presents to them of our grand natural phenomena and with his graphic accounts of the labours of his fellow-workers in the fields of science.

MECHANICAL REFINEMENTS.—No. X.

To the Editor of Engineering.

Sir,—By scrutinising inventors and inventions as we would painters and paintings, it would be comparatively easy to divide them into classes or schools, and determine by a slight analysis to which class an inventor belonged. An examination of a few of any inventor's contrivances will usually indicate the natural bent of his genius, and not only that, but one familiar with another's works may recognise the master spirit from some characteristic combination in the mechanical elements aside from the design or any previous knowledge.

Without any attempt at complete classification, among others will be found that kind of invention where new means are employed to accomplish new purposes; new ways and new tools substituted for old tools and handwork; a kind of invention where the inventor instead of inventing means to surmount an obstacle starts further back in the process and takes a channel in which the obstacle does not occur, that kind of invention where one piece or motion takes the place of two or many, and another class in which the word substitution seems more appropriate, wherein the work schemed for one purpose is applied to an entirely different one and often times with more successful results.

While this introduction, which has been called out by the many inventions brought to my notice, is somewhat foreign to the subject, a study of it may not be entirely uninteresting and not altogether useless, for in cases of interference and deciding which of two is the true inventor, and which the importer, no human testimony is as good as a comparison of their uncontested works. An inventor who simply substitutes the scheme of another to a new purpose can hardly claim comparative credit with an inventor of the first class; there is some merit, however, in knowing what use to make of a good thing. In the invention shown in Figs. 22 and 23, that class of inventors will find a little new thing subject to varied application.

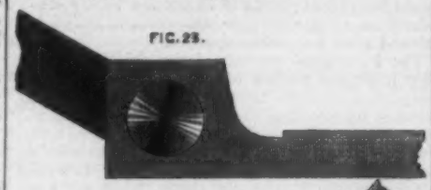


FIG. 23.

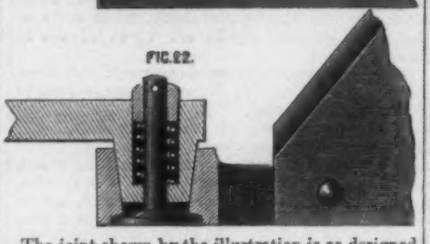


FIG. 22.

The joint shown by the illustration is as designed and patented for attaching the connecting rod to the knife or cutter bar of a harvesting machine, and is, as will be seen, a conical pin working in a conical seat kept in place by a slight coil spring which not only retains the cone in place, takes up and prevents loss motion, but what is also of equal importance does not tighten up the joints too tight. There is scarcely anything in the management of machinery more difficult than to keep the joints of reciprocating mechanism free from noise, and yet not so tight as to heat. A judicious application of this device with a proper adjustment of spring relative to the taper of the cone (and a taper of one in four or five will be found about right) will not only overcome the difficulty, but in addition, no amount of wear in the joint can change the length of the connexion.

It is perhaps presumptuous to assume any such thing as an improvement in the universally used and universally liked differential pulley blocks, but those who have used them for several years could not have failed to notice two features, which, if possible, would be desirable to have different. By constant use the wearing of the chain and the wearing of the sheaves changes their relative pitches, so that after awhile the chain rides the teeth. This at first takes place only occasionally, then more frequent, making it a bother first, then a nuisance, and, finally, rubbish. This defect might be partially obviated by the manufacturer furnishing sheaves of slightly increased diameter, making them good for some years more. Another defect, and one that shows itself at first and increases as they grow old, is when using them in confined places, or for drawing weights along the ground the trouble of keeping the slack chain so that it will enter on the sheave properly. This often requires the services of an extra hand, and is entirely obviated by the device shown in Figs. 24 and 25. The two slack chains passing through loops in the pendulum arms are guided direct on to the sheaves. Each arm has a sort of a rock shaft cast with it, which, passing through two ears cast on the main yoke, prevents the arm from getting out of line sideways and yet leaves it free to turn, so the chain may be worked at any angle from vertical to horisontal. This is in one sense, an improvement in the wrong direction, that is, there are three pieces in the place of one, but it is something that should be done, and this does it effectually. Whoever can invent or design a yoke requiring but one piece that will accomplish the same result as the three, will do nine times better.

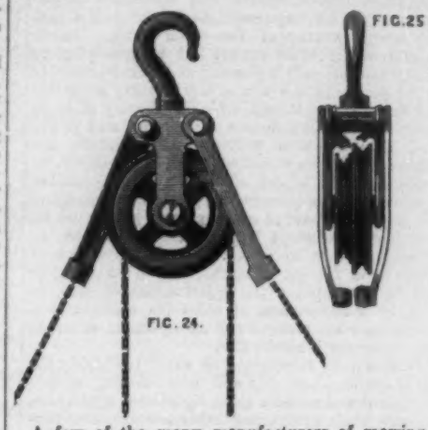


FIG. 24. FIG. 25

A few of the many manufacturers of mowing and reaping machines have discovered the fact that the success of their business depends as much on the excellence of the workmanship bestowed as on the peculiar plan of their machine, and fewer still that the cutting apparatus is the most vital part of all. It is but within the last three or four years and now but with a few firms that any special pains are taken with the fingers or guards and their cutting edges over which the knife works. By forging the guards of solid steel or of iron to be subsequently case hardened and sawing the slot out of the solid a degree of excellence is reached approaching perfection. The process of forging at first adopted was to cut blanks from plain bars of metal drawn down each end under the hammer or rolls, and swaged into shape under the drop press. One form of such guard is shown at A and B, Fig. 26. There has been recently successfully introduced a new method of forming the blanks, which consists in having the metal rolled in bars of the form shown in section at C, which being cut as at D and E form blanks without waste and ready for the finishing dies without forging.

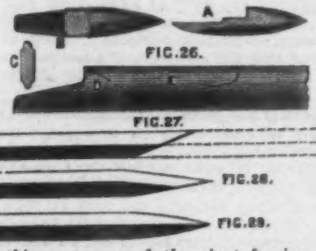


FIG. 26.

FIG. 27.

FIG. 28.

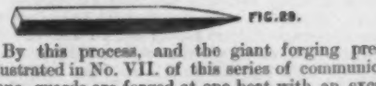


FIG. 29.

By this process, and the giant forging press, illustrated in No. VII. of this series of communications, guards are forged at one heat with an excellence depending simply on the excellence of the dies. This kind of a short cut for shaping or forging metals may be applied to various other purposes, that, for instance, of pointing harrow teeth or tines. If the square bars of iron or steel, from which they are usually made, be cut diagonally as shown in Fig. 27, which may be done by cutting proper grooves in the blades of any ordinary shearing machine, and bent as shown in Fig. 28, two or three blows of the swaging dies will make a complete finished job. In this there are two points gained, very little labour is required to do the work, and that wholly of an unskilled kind.

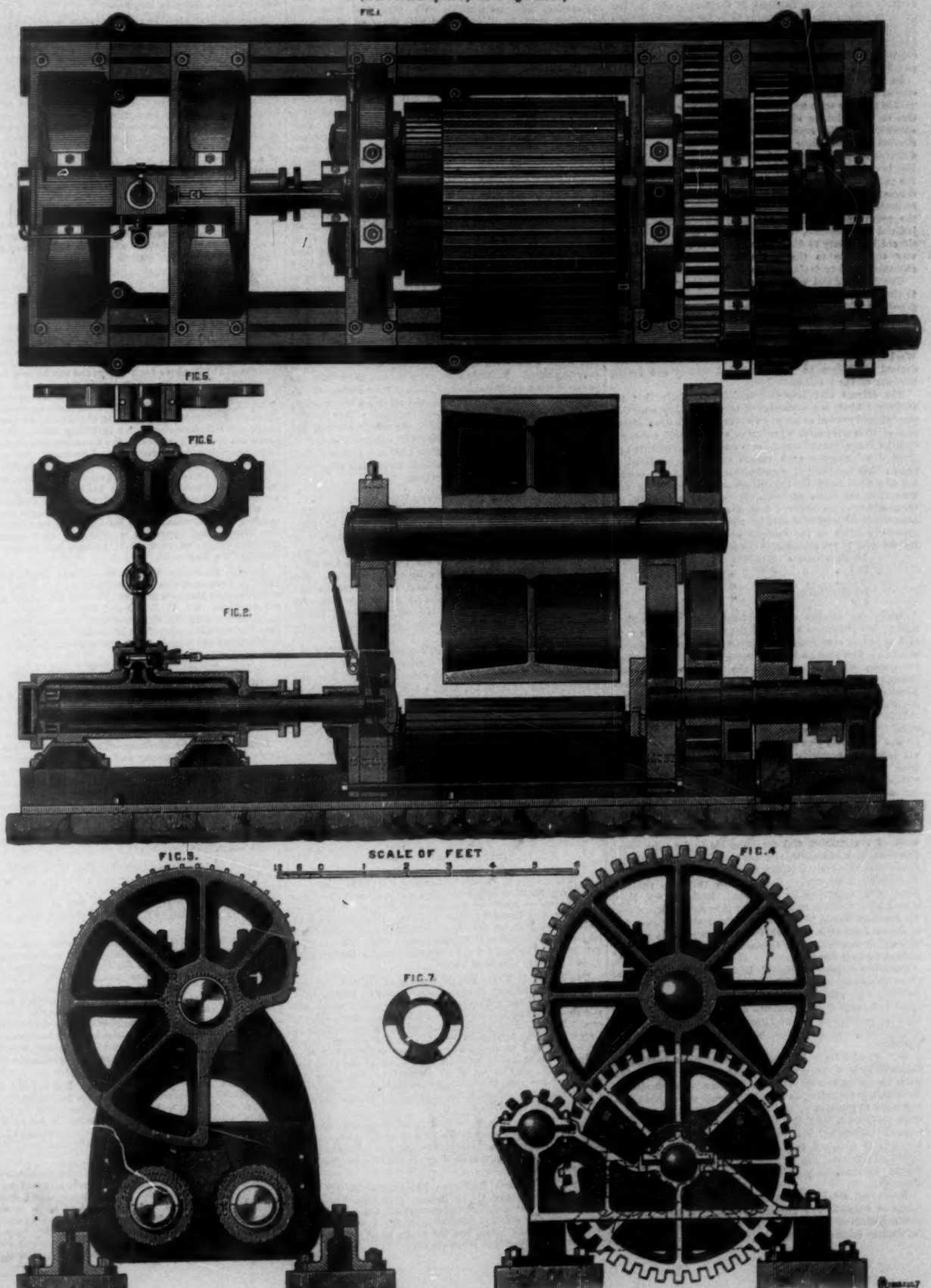
I am, yours truly,

An English Engineer in America.

The Meyer System.—The double bogie four cylinder engine "l'Avenir," designed by Messrs. Meyer, and built by the company of Fives-Lille, in France, has just been tried in Switzerland between Neufchatel and Lachaux-de-fonds in the Tura mountains. The engine took with ease a train of fourteen wagons, weighing 135 tons gross, up the gradients of 27 per mille, or 1 in 37. It appears by an advertisement in the *Moniteur des Intérêts Matériels* that this same engine is now offered for sale.

DANKS'S SQUEEZER FOR PUDDLED BALLS.

(*For Description, see Page* 220.)



NOTES FROM PARIS.

Paris, Oct. 2, 1871.

French Engine Drivers and Firemen.

Whilst the struggle between labour and capital is actively continued in England, in Germany, and in Belgium, it appears for the moment to be forgotten in France. In the midst, however, of the general quietude, the natural results of the reorganisation of work, there is apparent a certain agitation amongst railway engine drivers and firemen.

In November, 1870, during the siege of Paris, the engine drivers of the various railways who were confined within the city were occupied in drawing up a general petition to the Minister of Public Works, with the object of obtaining certain ameliorations in their position. They decided to expose their grievances to the presidents of the different railway companies before applying to the Minister. But towards the end of April an engineer, who possessed the petition, which had been prepared by the society, was denounced by the police of Nevers as implicated in the insurrection. When he was arrested he was found to have the papers relating to the alleged grievances. After a judicial examination, the Minister of Public Works considered it his duty to draw the attention of the various railway companies to the fact that there existed a non-authorised society prejudicial to their interests.

The directors had recourse to some repressive measures to check this movement. But these measures, as they are generally adopted in similar cases, did not prevent the drivers from organising the manifestation of their grievances. And to-day they have formed a society which includes nearly 6000 members; the Minister of Public Works has received their petition. They have also addressed themselves to the National Assembly and to the Minister of the Interior.

The drivers and firemen complain especially that too prolonged hours are demanded of them, and they wish that they should receive extra pay for every hour's work after a day of 10 hours; that continuous work should never exceed 14 hours, except under the pressure of necessity; that three days' absence each month should be accorded to them; that the rates of wages should be regulated according to a fixed tariff for the drivers as well as for the firemen; that the latter alone should be, after a fit examination, admitted as drivers, and that the employment of inexperienced helpers should be abandoned. The petition especially refers to the increase of wages, and the petitioners wish to see established the following tariff:

1st class drivers	3300 francs	per annum
2nd	„ „	3000	„ „
3rd	„ „	2700	„ „
1st class firemen	2100	„	„
2nd	„ „	1800	„ „

Actually the salaries are considerably lower than these figures, but premiums are added dependent upon the rates of fuel and oil consumed per mile according to the economy effected. The petition is silent upon the question of these premiums, which often raises the wages of the most laborious and expert men above the prices just quoted. Finally, the last request touches upon the improvement of the condition of retirement.

It is very certain that the drivers and firemen form a class of workmen very worthy of the greatest interest. The lives of millions of passengers are in their hands; their tasks are laborious, requiring continuous care, and not exempt from danger; they are subject to all the variations of weather, and sometimes contract from prolonged service maladies peculiar to their calling. But especially their work demands advanced intelligence, constant sobriety, coolness, and presence of mind.

The driver is generally intrusted with a portion of the work of maintaining and repairing his engine; he must, therefore, be a mechanic, and it is from the most intelligent fitters that this branch of the railway service is recruited. In addition, a locomotive is a machine costly in the first place, and expensive to maintain. Each engine, then, should have a driver responsible for it to such a degree, that his interests should be bound up in those of his engine, and to obtain from each machine the greatest possible amount of duty, it is necessary to obtain from the men assiduous, careful, and regular work.

For our own part we should be disposed to approve of those demands of the drivers having reference to the duration and requirements of their work; too much is often demanded from them, and it must not be forgotten that the security of life and property is placed under the responsibility of employés too often taxed beyond endurance.

But it must be recollected that even by reason of the duties of their posts, the drivers and firemen are suitably paid, in an especially equitable manner, since besides a fixed salary according to class, they receive premiums proportioned to the salary, and to the quantity and quality of work performed. As fuel is very dear in France, a great relative importance has been given to the premiums for economy in coal. A very complete system exists for accurately ascertaining the mileage and consumption of each engine, so that the premiums are awarded with perfect accuracy.

We do not think, then, it would do well to increase the wages at a fixed rate, and we consider that the just and liberal system of premiums should rest undisturbed. As to the various other clauses which the petition contains, it is only just that they should be carefully considered. It is only fair that the demands of the drivers should be examined into in a spirit of equity and conciliation. The class is excellent in general, and its members declare that they do not wish to resort to a strike; they expose their grievances with moderation. We may add that they repudiate entirely all connexion with the men of disorder who upheld the Commune. All things considered, it is a matter for regret that certain companies have seen fit to resort to extreme measures upon the organisers of this movement.

Ballast Wagons.

The Society of Encouragement has just given its approbation to a kind of ballast wagon, submitted for examination by M. Muygens, mechanical engineer in Paris. Ballast is generally carried in spoil wagons. The workmen who load them at the pits go with the ballast train to unload them at the depôt, then they remount the train to return to the pit, to repeat the same operations.

In these manœuvres there is a waste of time in the going to and fro of the workmen in the wagons. These men are obliged to attend the trains, and from this system, beside the delay, arise sometimes accidents more or less important.

M. Muygens has in his modification two objects in view, security and economy. He divides into two parts the floor of the wagon, each part being hinged to the frame by a longitudinal axis, in a plane a little nearer the middle of the wagon than to the edge, in such a way that the half floor is able to tip around the axis. The vertical and lateral sides are attached to hinges at the upper part, and by hooks to the lower part, in such a way that when the parts of the wagon are thrown out of gear the ballast slides from the inclined planes of the two half platforms, and spreads on each side of the rails, without, however, covering them. Railway companies do not, as a rule, approve of more varieties than possible in their rolling stock; they wish that ballast wagons should serve for transporting rails, sleepers, bricks, and other materials; they would, however, find a great advantage in the employment of the Muygens system, which considerably reduces the cost of hand labour. The inventor claims that one man is able to discharge in five minutes 15 wagons, which now require 45 workmen, and a time of 20 minutes.

Blasting Timber with Dynamite.

Last year at the commencement of the war a tremendous storm inflicted serious damage in the great forest of Haye (Meurthe-Moselle). The ground being weak, and the wind exerting a great force against the tops of the trees, a large number were thrown down. Recently the State has taken steps to sell these fallen trees by public auction. The stumps were taken off with the saw, and the trunks were cleared and raised. The beech-roots having become very hard by a long exposure to the air, they could not be cheaply removed, and there remained on the ground a very large amount of timber.

An engineer thought of applying the method that had been followed with success in similar cases in Germany; recourse was therefore had to dynamite. In each root, and following the axis of the tree, a hole was drilled with an auger from 9 in. to 15 in. deep, and $\frac{3}{4}$ in. in diameter. A dynamite cartridge, of about 50 grammes, provided with a fulminating cap, and a length of ordinary mine fuse, was placed at the bottom of the hole. When the charge was tamped the explosion was made, which divided the root into quarters, after which it was easy to reduce it by ordinary means into convenient sizes. By aid of this arrangement each woodman was able to break up $2\frac{1}{2}$ cubic yards a day with an expense of about 3 francs for dynamite, implements, and hand labour. In this manner profitable results were obtained from timber which would otherwise have been abandoned.

FOREIGN AND COLONIAL NOTES.

Rolling Stock in Belgium.—It is computed that there are now orders in course of execution in Belgian mechanical establishments for 4700 trucks and vans. Contracts for 1020 additional trucks for the Belgian State lines have just been let; the rate for the coal trucks ranged from 93*l.* to 103*l.* per truck. Contracts for 24 locomotives for the Belgian State lines have also been let.

The Kistna Bridge.—The bridge over the Kistna, now the only break in railway communication between Bombay and Madras, has been making good progress. It is under the sole charge of Mr. Lindsley, who has had much experience in erecting iron bridges for the Great Indian Peninsula Railway Company. The land piers on the Bombay side are being pushed on and arrangements are being made for the river bed piers being laid in as soon as the fall of the river will admit of it, that is by about December. The piers are formed of the great iron cylinders set side by side; they are 7 ft. in diameter and are bolted to the solid granite rock below and filled with concrete.

Argentine Telegraphy.—A line of telegraph uniting Buenos Ayres with Valparaiso, by way of the Andes, is expected to be opened for business this autumn. Five hundred miles had been completed in August, the total length being 1200 miles.

The Nizam's State Railway.—This line, which will effect a junction with the Great Indian Peninsula system, is stated to be not making much progress. Most of the embankments and cuttings have been executed up to Tandoor—a distance of 40 miles, but the works have been stopped from some cause, which is not stated.

A New Pier at New York.—The construction of a new pier at the battery, New York, is being pushed forward rapidly. Already 12,000 square yards of mud are shown, by a recent report, to have been taken from the bed of the river, while at the same date 10,000 square yards of stone had been dumped and levelled in its place.

American Patents.—In an application recently filed, Mr. David Eynon claimed the combination in a machine for making spikes of three independent machines, viz., a rolling mill, a furnace, and a spike machine. The primary examiner, refusing the case, held that there could be no patentable combination of machines not connected by operating mechanism. The case was carried, on appeal by Mr. Eynon's attorney, to the Commissioner of Patents, who has decided that there may be a patentable combination of independent machines if each contributes something towards the production of a new, better, or more economical result. The Commissioner also held that the doctrine that all the parts of a valid combination must necessarily be connected by operating mechanism, and that the product must be transferred from one device to another in the combination by automatic process, is illogical and pernicious.

Canadian Telegraphy.—The Montreal Telegraph Company has completed a line to Bayfield, in the county of Huron, *viâ* Brucefield and Varna. Offices have been opened at all these points. Another office has also been opened at Embro, in the county of Oxford, Ontario.

Australian Steam Navigation Company.—This company has declared a dividend at the rate of 9 per cent. per annum. This dividend was obtained after writing off 19,603*l.* for depreciation of property.

Canadian Lighthouses.—A lighthouse has been erected by the Government of Canada on the north-west point of Cape Chatte in the Gulf of St. Lawrence. A white flash light is shown, with an interval of 20 seconds between each flash. It is elevated 110 ft. above high water, and can be seen in clear weather about 18 miles. The lighthouse is a low square tower with dwelling-house combined, painted white, and standing at an elevation of 37 ft. from base to vane. The illuminating apparatus is catoptric, there being six powerful lamps and reflectors placed on a revolving frame. A lighthouse has also been erected by the Canadian Government in Cape Magdalen in the Gulf of St. Lawrence. A revolving red and white light is exhibited, showing red and white every four minutes, there being an interval of two minutes between each flash. The light is elevated 147 ft. above high water, and can be seen in clear weather, the red light 15 miles and the white light 20 miles. The tower is an hexagonal wooden building painted white, and it is 54 ft. high from base to vane. The illuminating apparatus is catoptric, there being four powerful lamps and reflectors. The light was exhibited for the first time August 21.

Another Australian Steam Line.—Messrs. Bright Brothers and Co., have some idea of establishing a regular line of mail and passenger steamers between Victoria and Great Britain, *viâ* the Cape. Mr. C. Bright and Captain Grey have had an interview with the chief secretary upon the subject, and have laid certain propositions before him which the Victorian Government has promised to consider at the earliest possible opportunity.

Failure of a Pontoon Bridge.—A pontoon bridge lately constructed at Mutira, "broke away," August 14. Several natives who were crossing at the time and others who had been placed upon the bridge to watch its struggles against a furious current were carried away on the runaway portions of the work. It is stated, however, that no lives were lost.

Canadian Pacific Railway.—The surveys of this great line are rapidly advancing and sufficient information will very shortly be in possession of the Canadian Government to enable it to enter into negotiations with intending contractors. For the greater part of the distance the route is known to traverse a region peculiarly adapted to railway construction. A broad expanse of level prairie will compensate for more arduous work between Montreal and Fort Gurry, and between the eastern slope of the rocky mountains and the Pacific coast.

Torpedo Boats.—It is announced that three torpedo boats for conveying torpedoes to an enemy's ship are now building at Dantzic for the use of the fleet of the German empire. The boats are 60 ft. long, 7 ft. wide, and in the shape of a fish. They are propelled by steam, petroleum being the fuel used.

The Australian Overland Telegraph.—No time has been lost by the South Australian Government in the equipment of an expedition to complete the Northern territory sections of the great Australian overland telegraph. Two vessels and the steamer Omeo were chartered for Port Darwin, and two sailing ships for the Roper river, the object being to convey stock and stores for carrying on the work. Mr. R. C. Patterson has the general charge of the expedition, Mr. W. Hutt being his second in command. They took with them upwards of 100 men, and have all the necessary means and appliances for prosecuting the undertaking with the utmost vigour.

Brazilian Telegraphy.—Sir Charles Bright, Mr. C. E. Webb, Mr. M. F. Jones, concessionaires for the construction of a line of telegraph along the Brazilian coast, have made a claim against the Brazilian Government for an alleged infringement of their rights through a concession to Messrs. Lanzes for a telegraph cable from Rio de Janeiro to Buenos Ayres.

The East River Bridge.—The caisson for the abutment of the East River Bridge on the New York side was recently towed into its final position. The caisson is oblong in shape, being 172 ft. long and 102 ft wide. The main portion is 13 ft. deep, and the fangs or wedges 9½ ft., making the entire depth 22½ ft. The planks are screwed together with huge wrought-iron bolts, and the crevices are carefully caulked with oakum and pitch, so as to be completely water-tight.

ON THE APPLICATION OF WATER PRESSURE TO MACHINERY AND PLANT.

To the Editor of Engineering.

Sir,—It has often occurred to me that a large field, embracing the above class of work, lying between that occupied by the hydraulic machinery of Sir William Armstrong, and an infinite number of smaller but ingenious tools brought out by others, is yet open for cultivation and improvement. The well-known Armstrong inventions are more especially adapted to the requirements of civil engineering, where greatly different amounts of power are required, and the facility of applying the same at given points over large areas, is essential, yet, when we look round our large shipbuilding and engineering establishments of the present day, we find that they also are measured as to their area by acres, and the distances over which the power given out by the engine has to be transmitted, can be measured in a similar ratio. Such being the case, the transmission of power by shafting becomes both cumbrous and expensive, and this can only be partially remedied by having the engine power divided, and placed at different points, involving greatly increased expenditure of capital, extra labour, fuel, room, stores, and insurance.

The waste of power, the loss of steam, by radiation, and losses by friction, in a large shipbuilding and engineering establishment (and they are now, where possible, always combined), is very great, and not creditable to our engineers and machine makers. It would be an interesting investigation to endeavour to arrive at the useful effects obtained from the engines and boilers in such cases. Apart from this let us look at the chief class of machinery used in the construction of ships, girders, and boilers, say, for example, those used for punching and shearing. Observe the multiplication of parts in getting up the power, the loss from the friction of all the shafts, collars, and slides; the extravagant consumption of steam by the donkey engine, if one is attached to the machine, or the wear and tear of a belt running constantly, whether work is being done by the machine or not. All that is really required in such machines is a comparatively small vertical motion; yet to obtain this we are compelled to have a great length of horizontal shafting, to transmit from this again by a belt, which again drives several smaller shafts with gearing exposed to the dust and weather; then we have either a cam or an eccentric to get the motion, and that an invariable one, of which more anon; and, finally, out of this mountain in labour comes forth verily but a small mouse, when, as is often the case, all we require done, is the shearing or punching of an iron plate of ordinary size.

Now, these may seem small matters for regret, viewed commercially at the present time, when trade is unusually brisk, prices good, and the demand greater than the supply, rendering competition in cheapening production less keen. But this state of things, from sad experience, we know cannot last, and those who have the best and most economical plant will be the best able to bear the reduction of prices which is sure to follow.

It is useless, however, telling a patient of his ailments if you have not a remedy to propose, and the remedy to the state of matters slightly touched upon above is indicated by the title of this letter. For any class of machinery requiring power and a reciprocating motion only, there is no more direct means of obtaining these than by the use of hydraulic pressure. It has the least friction, it involves the smallest number of working parts, is easily applied where wanted without gearing—hence its convenience—one of its chief merits, while owing to its want of elasticity and other properties, water can be taken at a distant point from the first motion or engine with comparatively slight loss of useful effect.

It is safe, the pressure at which we can work is practically only limited by the mechanical difficulties arising from the smallness of the working parts then required, which renders the very high pressure unadvisable. Power is only consumed when work is to be done, for by means of the accumulator or regulating reservoir the power given out by the engine is stored up while the machines are idle and is ready for distribution to them when they commence to work.

The accumulator or regulator, as I prefer to call it, acts as an engineman, for it can be arranged to close the steam and throttle valves, and regulate the supply from the pumps as required, and could with equal ease regulate the supply of coals to the furnaces. Apart from all this there is a vast field open to engineers and shipbuilders in reference to the employment of water pressure by distribution to moulding and bending presses for ironwork, there is work in the boiler yard—rivetting especially—punching, shearing, and many other requirements, such as the working of cranes and travellers, all of which are intermittent in their requirements of power, and under present circumstances requiring a constant supply of it to be furnished by engines and boilers whether wanted or not.

It is not my purpose to describe the details of hydraulic machinery, but to point out the field requiring cultivation, not to say irrigation. There is no middle course; my experience has been, that the small class of hydraulic machines above referred to are little better than toys, and a waste of ingenuity and money. If the system is to be adopted at all, we must take a broad view of it, and start from the commencement, by laying out our yards or works as if we were surveying a town for gas or water supply, and put our pipes down by the side of our vessels, boilers, or bridges, and from them branch out the smaller arteries wherewith to feed the individual machines, which will then do the work required and no more. And when this is done—as it will be by some large-minded and far-seeing capitalist—as a whole, as it has been to a certain extent done already by many firms under the writer's superintendence, then shall we wonder that the engineers of the nineteenth century, although certainly attaining great results, nevertheless used such clumsy means, when one of nature's most bountiful gifts lay close to their hands to utilise.

These remarks are respectfully submitted, not as the views of a theorist, but as the result of practical experience and study, and with the hope that it may be productive of some practical application of the writer's ideas on a large scale.

There are many other views of the subject, and the detail part is of the greatest importance to insure a successful result, and these may form the subject of a future letter.

Yours obediently,
Ralph Hart Tweddell.

20, Roker-terrace, near Sunderland,
September 21, 1871.

A PROFESSIONAL VISION!

To the Editor of Engineering.

Sir,—Many letters have recently appeared in the newspapers respecting the necessity and practicability of a tunnel under the Channel, to connect England with France, and like the proposals for a railway between England and India, no sooner is one scheme advanced, than many others are shown by their partisans to be better and more practical. May I be allowed the use of your columns to enable me to enter the lists among these enthusiastic projectors? It does not signify who first originated the proposal of a tunnel between Dover and Calais, or between Dungeness and Cape Grisnez, but I am not too bold in believing the proposals I am going to put forward are original. It has occurred to me there are other and more practical works, which might be undertaken with honour to this country, and if proved by execution to be successful would soon lead to the connexion between France and England being completed. I propose a tunnel should be constructed connecting the main land with the Isle of Wight, that the material taken out should be used for forming a grand harbour of refuge at the mouth of the Southampton Waters. I then propose in connexion with this harbour, though not starting from it, a ship canal from Southampton to London. The facilities for making this canal are not very well known, but living in Hampshire and from other professional circumstances, and being conversant with the country through which the canal would pass, I can state with confidence such difficulties as might occur would prove paltry by the side of those encountered in the formation of the Suez Canal; in fact, nearly one-half the work is done in the shape of the Basingstoke and Andover Canals, which might be utilised when found advisable. A magnificent system of docks could be formed on the south side of the Thames, communicating with all the railways in the kingdom. Looking at the enormous relief such a system would be to the East of London, without interfering with the exclusiveness of the West End on the North side of the river, and looking at the benefit it would be to all ships and steamers having to go through the Straits of Dover, I believe the capital might be obtained and profitably used for the purpose. If the tunnel to connect the mainland with the Isle of Wight was made, and experience gained, then a tunnel might be formed from St. Catherine's Point at the back of the island to the mainland of France, near Cherbourg, the material on the English side being used for an enormous breakwater enclosing Ventnor Bay. But may I ask whether, before such work is undertaken, there is not a more natural Siamese engineering link which should be constructed to connect England and Ireland? There is certainly just now a much stronger reason to connect England and Ireland than England and France. A tunnel to connect the cliffs north of Arklow with the south-west part of Carnarvon, would be a work to undertake worthy of the British Empire; but your readers may say I am only dreaming. Our fathers did not get so far advanced as dreaming of the Suez Canal, the Mont Cenis Tunnel, the world-encircling telegraph; is it too much, then, to think what we are dreaming of our children may see completed, and for us to ask after the experience of this generation, what will their children see?

Your obedient Servant,
London, October 2, 1871. Hardy Wells.

Railway Wagon Building in Germany.—The large manufactory for railway wagons of Reiffert, at Bockenheim, has passed into the hands of a joint-stock company, and as rolling stock is much required just now, and the establishment is of good repute, the shares are readily taken, the amount being only 400,000 thalers.

The European and North American Railway.—The European and North American Railway, an important line between Bangor (Maine) and St. John, New Brunswick, which unites the British provinces with the United States, was completed on September 20, the last rail being laid at noon. The formal opening of the road is to be celebrated this month.

The late Mr. Thomas Baker.—Mr. Thomas Baker, a self-taught mathematician and practical engineer, has just ended his days as a "poor brother" in the Hospital of the Charterhouse. He was the son of a farmer at Old Park, Durham, and the solution of many of the most difficult problems in the earlier stages of railway surveying and construction was due to his genius. It was he who invented the celebrated method of laying down railway curves, and the *Durham Advertiser* says that he "laid out the Stockton and Darlington Railway, the first line in the kingdom." He also laid out the atmospheric line from Dublin to Kingstown, and in the infancy of the railroad system he was largely engaged in many parts of the kingdom. The last line which he surveyed was that projected by Mr. George Hudson for connecting Lowestoft with London, and for making that town on the eastern coast a second Liverpool, a project which the ruin of the "Railway King" extinguished. Mr. Baker was the author of several works on mathematics, both theoretical and practical; of these the best known are the "Elements and Practice of Mensuration," a "Treatise on Land and Engineering Surveying," the "Principles and Practice of Statics and Dynamics," a "Treatise on Subterranean Surveying," the "Mechanical Companion," and "An Original Method of Integration."

AMERICAN PATENT LEGISLATION.

The following is an extract from the address delivered, at a quarterly meeting of London Patent Solicitors, on the 4th inst., by George Haseltine, M.A., LL.B., the chairman:

"American legislation on patents for inventions is based on the first article of the Constitution. The eighth section declares that Congress shall have power to promote the progress of science and the useful arts by securing authors and inventors the exclusive right to their respective writings and discoveries.

"The Colonial and State authorities had exercised to a limited extent the prerogative of awarding inventors exclusive privileges, but the Confederation which preceded the National Union was not empowered to grant protection to the productions of inventive or literary genius. The Constitution has not prohibited the States granting patents, but it was the evident intention of its framers to confine this class of legislation to Congress—an intention respected by local legislators who have enacted no *general* patent laws, and inventors have been so well content with the liberal character and efficient administration of the national system, that they have rarely sought other protection or additional rewards. The legislature of the Empire State in 1798 passed a *special* Act, granting Robert R. Livingston the exclusive right of constructing and navigating *every species* of boats, propelled by the force of fire or steam, within its jurisdiction, for the term of twenty years, provided he should, before the expiration of twelve months, construct a boat of 20 tons capacity, with a mean speed upon the Hudson river of 4 miles an hour. The patentee forfeited the grant, which was renewed to him and his associate Robert Fulton in 1803, and again five years later for terms of twenty years. This grant possesses a scientific and historical as well as legal interest. It affords an eloquent illustration of the infancy and progress of steam navigation, with which Fulton was so intimately identified—a progress that has attained a mean speed of 20 miles an hour upon the Hudson, and transformed a boat of 20 tons into a steam ship of more thousands. This fire steam navigation proved a commercial success, which excited the envy of losing competitors, whose infringement necessitated a Chancery suit—not an uncommon result in later times—that at once impoverished the plaintiffs and established the concurrent but subordinate jurisdiction of the States in patent legislation. The Court of Errors, of which Chancellor Kent, the American Blackstone, was then a justice, decided unanimously in favour of the local grant. The judges adopted, without reserve, the doctrine of State Sovereignty, which now finds little favour with American legislators, though the amended Constitution expressly declares that the powers not delegated to the nation are reserved to the States or to the people.

"The first Congress, recognising the justice and realising the policy of an efficient patent system, passed an Act to promote the progress of the useful arts, which was superseded three years later by a similar statute, and a Repealing Act was passed in 1836, which in turn was superseded by the general statute of 1870. Several minor Acts intervened, and notably the one increasing the original term of a patent to seventeen years, and equalising the fees to native and foreign inventors. Through all these changes the law makers have never questioned the equitable rights of invention, or the wisdom of satisfying these rights by exclusive privileges for a term of years. The Colonies and States, imitating the practice of the Mother Country, had more often granted patent privileges to importers than to inventors—a pernicious practice, that has found no recognition in the national legislation. Though the common law, that regards alike the importer and inventor, was the prevailing law of the States—a fact well known to the authors of the Constitution—and, subordinate to the statutes, was formally adopted by Congress, the American courts have never held that first importers are true inventors. The right to grant patents of importation is still vested in the States as the source of political power. The liberal legislation of Congress, which, recognising the universal brotherhood of genius, offers princely rewards to inventors without distinction and virtually without price, has made America the home of inventions—the paradise of patentees. Sixty thousand original patents have been granted in sixty months, and half as many applications rejected—on strict investigation of novelty—still the rate of issue continues, infusing new life into every branch of industry. The money value of these patents is counted by millions—their industrial value exceeds the national indebtedness. Modern inventions constitute a vast wealth of the Union, whose marvellous progress is less attributable to the richness of its mountains or the fertility of its plains, than to the restless genius of the people. The demand for new inventions is insatiable, enterprises are impatient, and the State that incited the ingenuity of a Fulton to design a 20-ton steamboat for the Hudson river, has recently offered a prize of 20,000*l.* to the pioneers of steam navigation on the Erie canal. Inventors are honoured as public benefactors, and the nation has erected to its hundred thousand patentees—the leaders of its grand army of industrial progress—a marble temple of art, the noblest structure ever dedicated to the genius of invention."

Engineering Progress in Belgium.—The Belgian Company for the construction of engines and railway material, of which Mr. Charles Evrard is the director-general, is about erecting additional workshops at their already very extensive establishments at Brussels and at La Croyère.

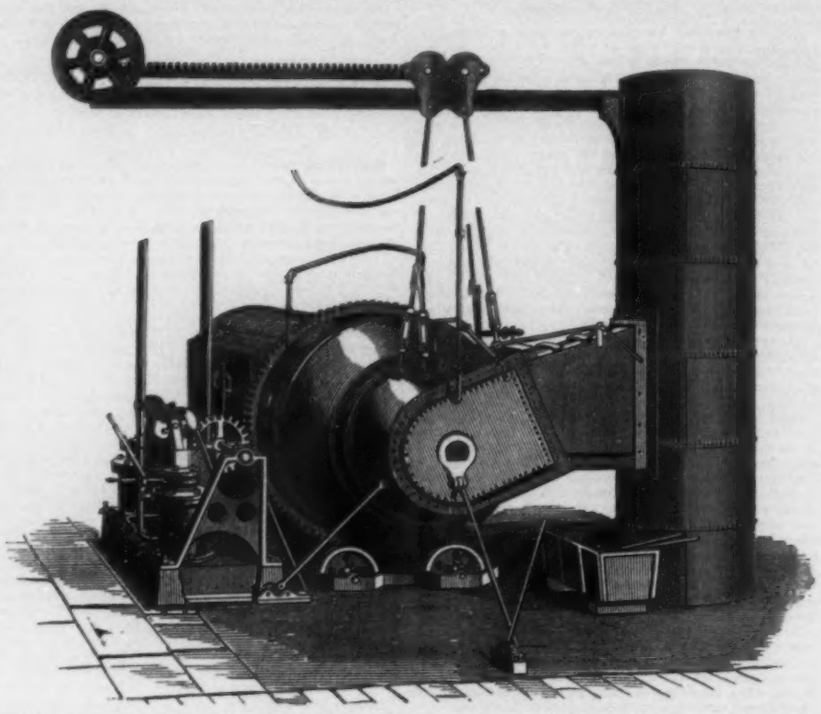
Bronze Guns.—The Royal Gun Factories in the Royal Arsenal, Woolwich, are again constructing bronze guns, but of a new description. Sixteen 9-pounders, of 3 in. bore, weighing 2 cwt., and about 3 ft. in length, are ordered to be cast for mountain service, and one has been sent to the arsenal at Cossipore, near Calcutta, India, as a pattern upon which Colonel R. H. Maxwell, Royal Artillery, the Superintendent of the Cossipore Foundry, will manufacture a supply for India.

DANKS'S REVOLVING PUDDLING FURNACE.

On the 1st September last we published an abstract of a paper read by Mr. Samuel Danks before the Iron and Steel Institute at Dudley. By the courtesy of Mr. Danks we are now enabled to publish details of his patent mechanical puddling furnace, the two-page engraving and the illustrations on page 217, which we give this week, having been prepared from a set of working drawings, kindly lent to us for the purpose, and from which a revolving puddling furnace is now being constructed in this country. By reference to these illustrations the principle upon which this apparatus acts will be very readily understood. The great object of the revolving furnace is to do away with the necessity for employing manual labour in puddling, but it is also claimed that it possesses the further advantages that larger balls can be produced by it at a single heat than is possible in the ordinary puddling furnace, that it is attended with a considerable economy in the amount of fuel required per ton of iron produced, and that it produces a yield never before attained, being frequently 10 to 12 per cent. in excess of the charge of pig metal. Furthermore it is asserted by Mr. Danks that his furnace makes steel or iron at pleasure, that eight to ten heats are made in ten hours; and that fifteen heats have been made per day when melted metal was charged. These are certainly most important advantages; and although in many quarters they have been regarded in this country as "too good to be true;" yet Mr. Danks has met his opponents by evidence which is worthy of the most careful attention, and has supported his cause so ably that we feel justified in laying his system prominently before our readers; while we are further justified in this course by information as to the good performance of Mr. Danks's furnace which has reached us from America through independent channels.

Mr. Danks's invention, it will be seen, consists of a furnace, the revolving refinery, and other component parts, which we now proceed to describe in further detail, referring for the purpose to our two-page illustration. The furnace has a firegrate in outward appearance like the ordinary puddling furnace, but differing from it in several important particulars. It is supplied with a fan blast under the grate to urge the fire and produce gas, and it has also another blast inlet in the rear of the grate and above the fire for the purpose of insuring the more perfect combustion of the fuel. This latter inlet consists of a pipe which communicates by a number of small tuyeres with the interior of the fire chamber. The blast is regulated by a valve by which the workman has a perfect control over the quantity of gas generated and consumed, and he is thus enabled to make the temperature suit the requirements of the charge in the different stages of the puddling process. The ashpit and firehole are closed by doors to prevent the escape of the blast except through the fire, and the firehole has a coil of wrought-iron water pipe cast into it for the purpose of allowing a stream of water to circulate around it and keep it cool. At the front of the furnace there is an opening or passage communicating with the interior of the rotatory refinery, the under side of which is formed into a bridge within which there is inserted a coil similar to that in the firehole. Fastened on to the bridge-plate is a ring with a flat surface on one side, which ring has a pipe or pipes cast into it, and is made in one piece or in sections. The face is cast on a metal chill to harden the part exposed to abrasion from the end of the chamber rubbing against it. The revolving chamber is made of two end pieces so formed as to be banded together with wrought-iron bands, and having detached rings on the part most exposed to the fire; the ends of the chamber are stepped for the reception of rollers which are so arranged as to both properly support it, and retain it in place, at the same time permitting its free rotation. The chamber rests upon these four rollers, and it has also suitable ribs for strengthening it with holes for rivetting the rings and stave plates upon it. The two ends are connected together by a series of stave plates to form a cylinder, these staves being of suitable length according to the desired size of the chamber. They are furnished with hollow ribs running longitudinally, which serve the double purpose of holding the fettling and keeping it cool, and, when rivetted together, form an open-ended cylinder, one end of which butts against the ring that is fastened to the bridge-plate where the gases are admitted over the bridge from the grate. The other open end serves the purpose of a doorway for the reception of the charges of iron, and also for their removal as well as for the escape of the products of combustion through a movable head piece which connects the revolving chamber with the chimney, when the furnace is in operation. This head piece is suspended by rods from a cradle sliding on a jib rail projecting from the flue or otherwise fixed in a suitable position, by which means it can be removed at pleasure. When it is fixed in its place in front of the cylinder—as it is when a charge is being puddled—the escaping gases pass through it into the stationary flue, and thence to the chimney or boiler. At this time it is held in position by suitable supports. It is also furnished with a stopper hole in front so that the operation going on within can be seen at all times, and an arrangement of water pipes is provided for the purpose of keeping it cool. The chamber rests upon the four rollers above referred to, and it is made to revolve by means of a toothed wheel fixed longitudinally upon it. A suitable engine is attached to each machine so that the chamber can be made to revolve at any speed

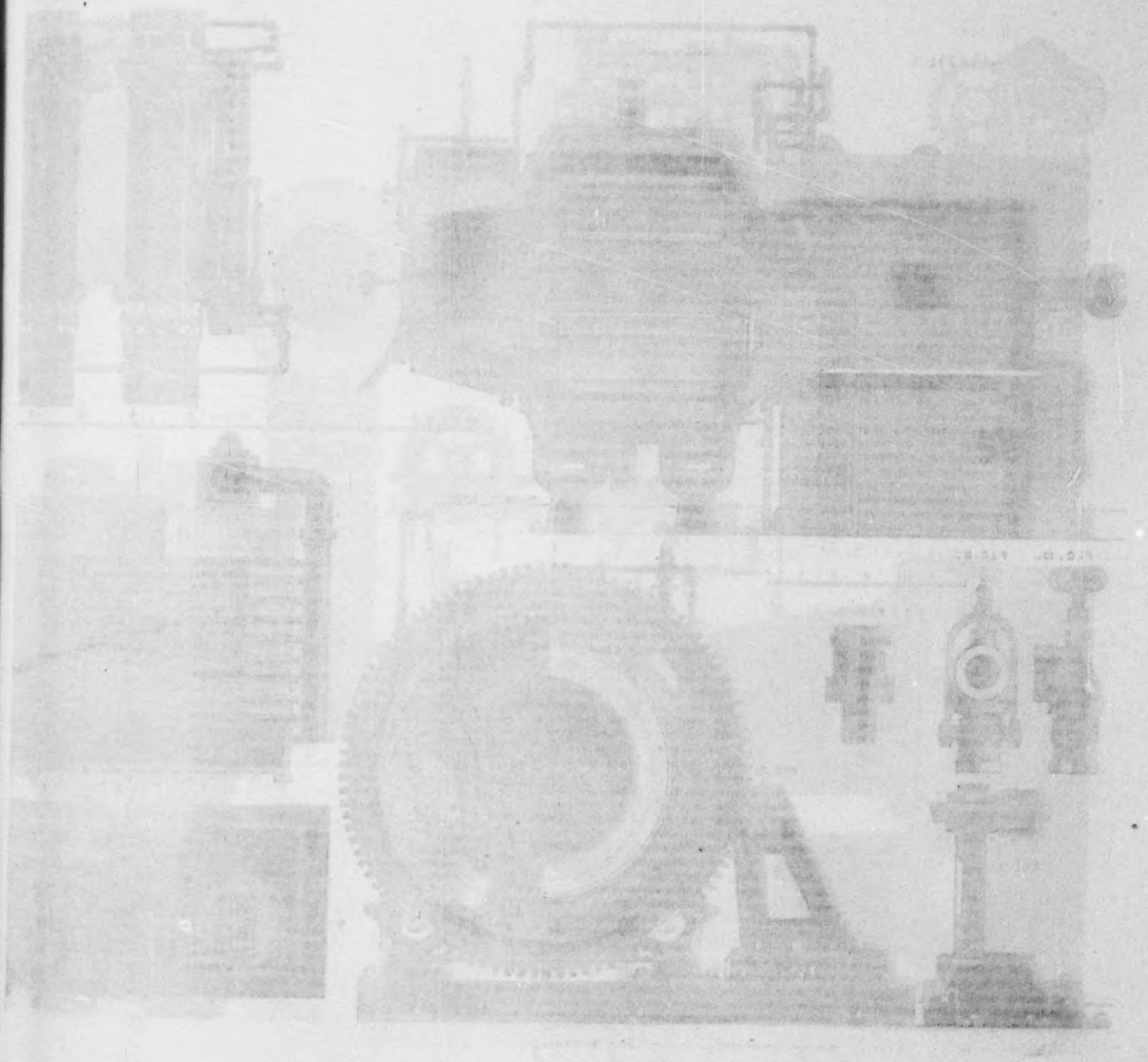
THE DANKS REVOLVING PUDDLING FURNACE.



that may be required according to the different stages of the operation. When it is desired to remove a ball from the chamber, the props of the movable head piece are removed and the flue hanging from the overhead rail is moved away. A large fork (*vide* Fig. 9) suspended from a crane is put into the vessel along one side, and the ball which, by a turn of the vessel is rolled on to the fork, is taken out and conveyed to the squeezer. The head piece is then replaced after a fresh charge has been put in, and the chamber is again in full working order. Of course, during this operation of withdrawing the ball and recharging, the blast is shut off and the fire confined within the furnace.

In Cincinnati, where the first of these furnaces was put up, puddled balls have been made of 650 to 1000 lb. each, and heats exceeding 1400 lb. each have been made into one ball. The machine, however, though of course most economically worked when producing large balls, can, by the assistance of hand labour, turn out small balls to suit existing hammers or squeezers, but it is found more profitable to puddle half a ton at a heat, and to let the furnace make its own one ball of the heat. To suit these large balls, a squeezer has been especially designed, and this should of course be set up wherever it is desired to use the revolving furnace to its best advantage. This squeezer is shown in the illustrations on page 217.

Such are the principal features of the "Danks patent revolving puddling furnace," and it has been admitted that in some respects it differs but slightly from revolving furnaces previously introduced. At a meeting of the Cleveland Institution of Mechanical Engineers, in May, 1868, Mr. Williams (manager for Messrs. Bolckow, Vaughan, and Co.) said that he did "not think the present puddling furnace would ever be improved, but rather get worse until they had brought into use a successful mechanical puddler — something that would accomplish what the revolving puddling furnace did. That furnace, so far as the mechanical part of it was concerned, had already been found to work most successfully; it had not, however, been brought into general use, simply because up to the present time it had been impossible to find for it a suitable lining. They wanted something except sand upon which to puddle; until this was found they could scarcely hope for further improvement." The want of a suitable lining appears to have been the chief thing that prevented Mr. Menelaus from accomplishing a success with his revolving puddler. Mr. Fothergill, in his remarks on the subject the other day at Dudley, stated that at one time when Mr. Menelaus's rotary furnace held out good prospects of success, there still remained two difficulties that he had not then conquered. Mr. Menelaus had introduced the pig iron into the rotary furnace, and he had produced in Mr. Fothergill's presence a very large and apparently a very satisfactory ball of iron; but it appeared to him that the fettling around the furnace seemed to get continually dislodged and broken as the contents assumed the malleable condition, and rolled about in the stage towards completion. It is on this very point of fettling that Mr. Danks affirms he has been enabled to make his furnace a success, and this is the most important feature in connexion with the invention. The foundation for the lining of the cylinder consists of a mixture of pulverised iron ore and pure lime, worked with water into the consistency of a thick paste. Upon the completion of the initial lining, a quantity of pulverised iron ore, about one-fifth of the total amount required to fettle the apparatus, is thrown in, the furnace is heated and made to revolve slowly until the iron is found to be completely melted, and the apparatus is then stopped. That part of the molten iron which has not been consumed by glazing the initial lining surface runs to the lowest level of the furnace and there forms a pool into which there are put a number of small and large lumps of iron ore of such dimensions as will be required to allow the said lumps to project over the surface of the liquid ore by from 2 to 6 in. This part of the fettling is allowed to set when a fresh quantity of pulverised ore is thrown in. The furnace is again made to rotate slightly until the newly added ore is liquefied, when the apparatus is again stopped and the pool is filled with lumps as before. The operation is continued in this way until the whole of the vessel is properly fettled. From 2 to 2½ tons of iron ore are required to fettle a 700 lb. furnace. The iron is charged into the furnace either in a solid or molten condition. When charged in the shape of pig iron, the melting down occupies from thirty to thirty-five minutes, during which a partial rotation is given to the furnace from time to time in order to expose equally all sides of the charge to the flame. When the whole of this is thoroughly melted the furnace is made to rotate once or twice per minute only during the first five or ten minutes, in order to obtain the most perfect action of the cinder upon the molten iron. A stream of water is injected through the stopper hole along and just above the line of contact between the floating cinder and the inner surface of the vessel on the descending side. A certain portion of uncontaminated cinder is thereby solidified on the metal surface, and is carried down into or below the bath of molten iron in a continuous stream, which, in rising up through the iron, combines with the impurities of the latter in a far more effectual and complete manner than any mode of puddling hitherto known can effect. On the expiration of the said five or ten minutes the iron begins to thicken, and the motion is stopped. The heat is then raised so that the cinder shall be perfectly liquefied, and the vessel is brought into such a position that the tap hole shall be just over the level of the iron, which by this time has become partly pasty. The puddler gently pushes back the iron and the cinder is made to run off. The heat is again raised and the furnace is put in motion at a velocity of from six to eight revolutions per minute, by which means the charge is dashed about violently in the furnace. A high temperature being kept up and the charge being continually turned over, the particles begin to adhere, when the velocity of the apparatus is lowered to from two to three revolutions per minute, upon which the ball then very speedily forms. The puddler then solidifies the front end of the ball by a few blows from a tool applied through the stopper hole, and it is withdrawn in the manner already described.



THE DANKS REVOLVIN

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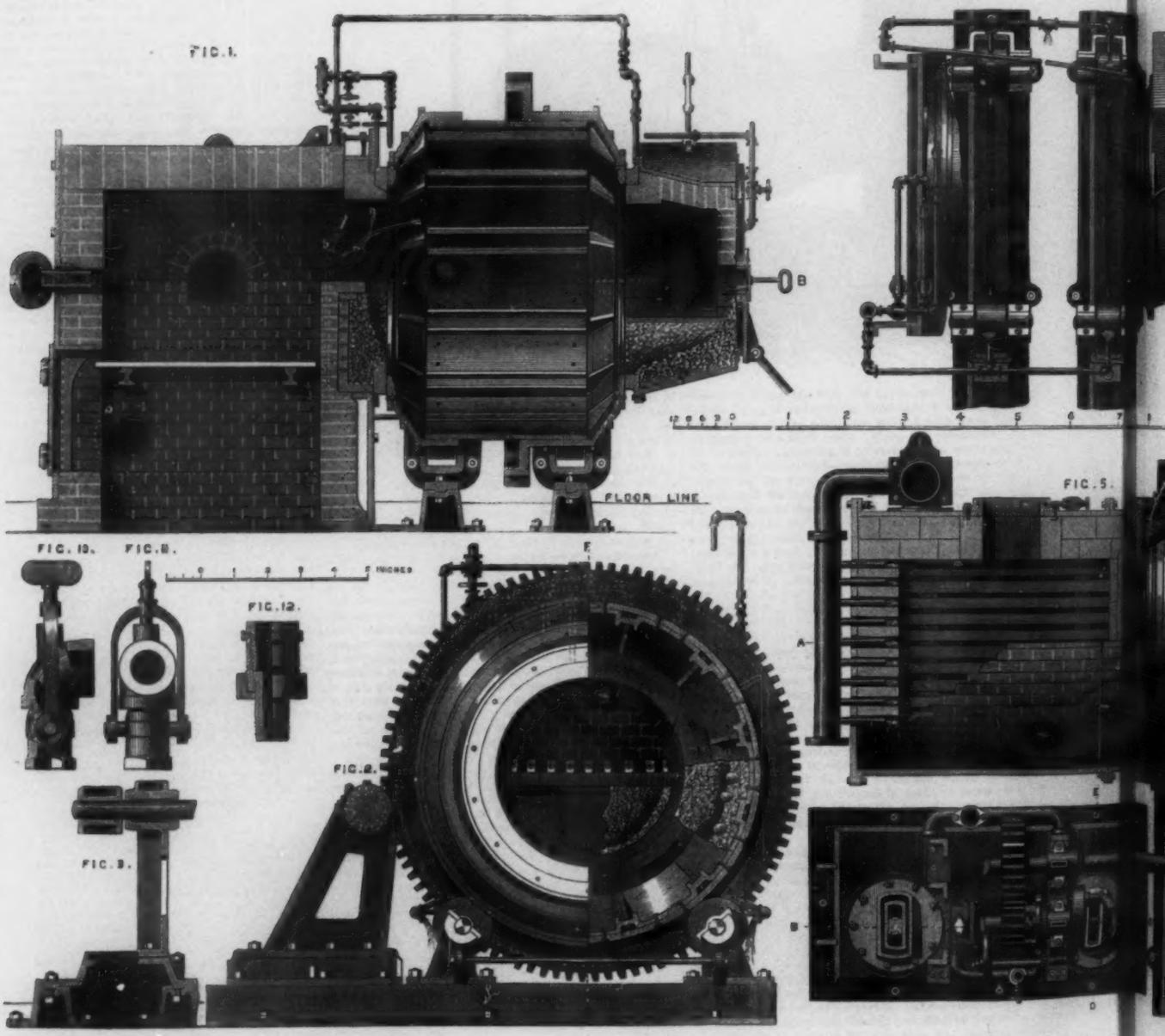
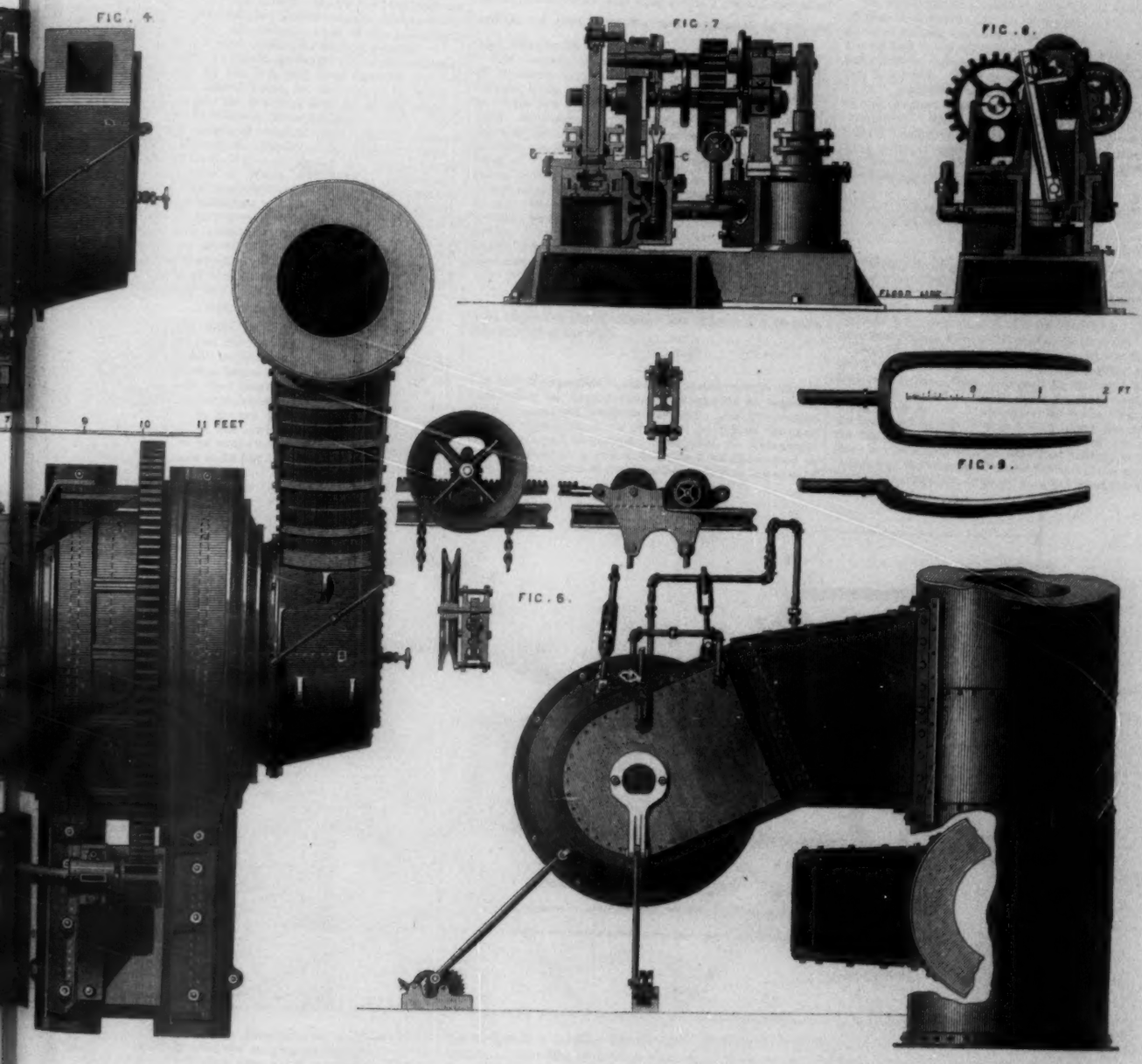


ING PUDDLING FURNACE.

(Description at Page 220.)



The increase of puddled iron yielded above the quantity of pig put into the furnace has been from 10 to 15 per cent., as much as 50 per cent. of iron being sometimes obtained out of the fettling. Mr. Danks considers that with a pig iron similar to that which in the South Staffordshire district is called "mine metal," the average yield in excess of the charge would be 6 per cent. In the abstract of Mr. Danks's paper, to which we have already referred (*vide* page 140 of the present volume), will be found particulars of some of the results already obtained with this furnace in America.

What is required for the fettling is an ore containing not more than 5 per cent. of silica, for the purer the ore is from silica the harder it is to melt, and it is necessary for the correct working of the rotary furnace that it should melt at a very high temperature. The fettling used by Mr. Danks in the United States is an ore obtained from Missouri, and where this is used it is asserted that the phosphorus and sulphur are almost entirely removed from the metal under treatment. Mr. Danks considers that in working the furnace in this country, some of the titanic ores may be turned to good account for fettling purposes.

In conclusion, we should state that this week a commission appointed by the Iron and Steel Institute left this country for the United States, for the purpose of investigating thoroughly the practical working of Mr. Danks's furnace. The members of this commission—which consists of thoroughly competent practical men, including amongst others, Mr. Snelus, the chemist of the Dowlais works—took out with them 40 tons of pig iron of various brands, including samples of Welsh, Staffordshire, Scotch, and Cleveland, so that their tests of the working of the furnace under different conditions will be very complete, and their report one of very great practical value. If the results obtained are as satisfactory as Mr. Danks fully expects them to be, the use of the furnace we have described will exercise a most important effect upon the British iron trade, and the report of the commission will, therefore, be looked forward to with very great interest.

STEAM ENGINE COEFFICIENTS.

To the Editor of Engineering.

Sir,—Mr. Smith, replying to my criticism of calculation of steam coefficients, begins by promising to prove that my conclusions have been based on erroneous assumptions. I am afraid he has written hurriedly to be in time for your next issue, and that he has not quite comprehended the nature of my assumptions, nor carried out his own to their legitimate results, or he would not have come forward pledged to vindicate them as he has done.

As the questions under discussion are as important as any in connexion with the progressive improving of the steam engine, I will place them again, as clearly as I can, before your readers.

I stated that "the total ratio of expansion calculated from capacities of cylinders and pressure, as cut off in high, is eleven times." I find this by measuring the space occupied by the steam in the small cylinder before expansion begins, and comparing that with the cubic capacity of the low cylinder. I find that the one is eleven times the other, and therefore the total ratio of expansion is *eleven times*.

The word "expansion" means *enlargement*, and has reference exclusively to relative volumes, and directly implies nothing about pressures. If we have one cubic foot of steam at 60 lb. pressure above zero, and if we expand it to have a volume of four cubic feet, the ratio of expansion is four times. If we find that the pressure at the enlarged volume is only 12 lb., this will not modify our statement of the ratio of expansion; that remains as neither more nor less than *four*, although the pressure is now only one-fifth of its original amount. All the science of steam is written on this acceptation of the expression "expansion." As Mr. Smith quotes a formula from Professor Rankine, perhaps what he says will be accepted as conclusive. In "Steam Engines and Prime Movers," at page 397, he will find: "Let v_1 represent the volume of admission, and v_2 the volume at the end of the expansion; then $\frac{v_2}{v_1} = r$ is the *ratio of expansion*." I have omitted the words irrelevant to the point.

Mr. Smith, on the other hand, maintains that in the above example the ratio of expansion is not *four* but *five*, because the final pressure is one-fifth. He says, where the initial pressure is 70, and final 4.875, to obtain theoretical results, we should put the total expansion as $\frac{70}{4.875} = 14.5$, irrespective of volumes.

The diagrams show that at effective cut-off the volume of the steam used each stroke is just *one-eleventh* of its volume, when, before entering the condenser, it is supposed to fill the low cylinder. I have reproduced the diagrams under discussion, and have shown on these what I have taken as the theoretical or effective cut-off, by the lines A B and *a b*, so drawn that the area included at B shall be equal to the area excluded at A. That this is the theoretical figure to be dealt with is no matter of opinion, but a mathematical fact, and will be recognised as such by all who receive its meaning. That is the card which, with the same steam and a clean cut-off, would give the same power. The portions of the high-pressure cylinder represented by the lines A B and *a b*, measure A B=.347 and *a b*=.304 of the length of the card or stroke.

$$\frac{.347 + .304}{2} = .325.$$

Also, neglecting piston rods, the low cylinder is 3.58 times the capacity of the high.

$$\frac{3.58}{11} = .325.$$

The ratio of expansion is, therefore, exactly eleven. Should a correction for disproportion of piston rods be required, there is a margin available for that. The compression curve at right-hand corner, if carried up beyond the point of lead, will pass to the right of the point, *a*. This should be substituted for *a*, and it will give *a b*=.320 instead of .304, or an addition of one-twentieth, which is in excess of the disproportion between the two rods. At the other end there is no correction required as there is no piston rod on top. I think it must be apparent to every reader that eleven has been arrived at as the ratio of expansion, not on any erroneous assumption, but by a careful treatment of the cards on a principle strictly correct.

I have also continued the expansion curves back to show a cut-off corresponding to a total ratio of expansion 14½ times. This is shown by the lines G H and *g h*. I have assumed that the compression reaches the initial pressure, it does not quite; had I corrected for this, these lines would have been still higher.

The areas contained in G H B A and *g h b a* make up the difference between 1+hyp. log. 11 and 1+hyp. log. 14½. Mr. Smith says that the theoretical duty of the steam shown on these cards includes these areas, whereas I maintain that these areas are above the theoretical duty of that steam admission or above perfection.

It is stated in the article under criticism (September 15) that this system of steam coefficients was introduced some time ago by the Messrs. Elder. I may state here that my system of steam coefficients has been in use for the last twelve years. It was published in the *Artizan* in 1860, along with my methods of treating indicator diagrams, geometrically, as shown on accompanying diagram. It was on my recommendation adopted by many Liverpool superintendent engineers, and about 1864 was presented by me to Mr. Alexander Elder, and the coefficients worked out by me for him on a set of cards he had brought with him to my house. The Messrs. Elder had not then adopted the system of steam coefficients, and I then pointed out to Mr. Alexander Elder of what value such a test would be to compare his brother's engines with those of other makers.

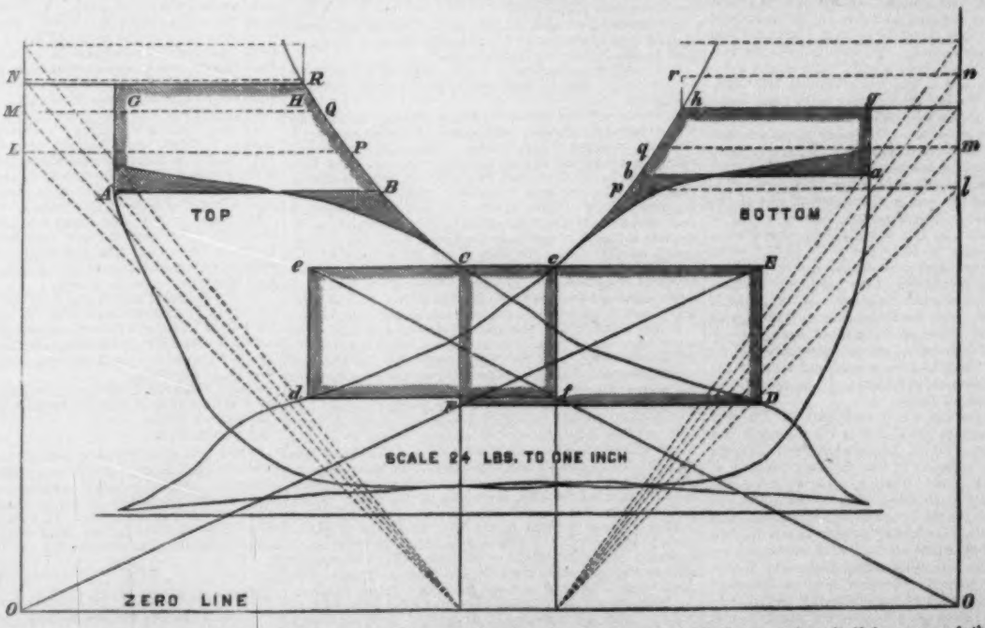
Mr. Smith thinks I have not fairly stated what is the coefficient of perfection, and he quotes me to show that I have given it without the back pressure as 3.154. But I have clearly said in my letter that "the coefficient due to such an expansion, and under mathematical conditions, is 1+hyp. log. 11=3.398. The low card shows a back pressure=1½ lb. Deducting this from the coefficient we get 3.154 as the greatest possible result even under mathematical conditions." And I still say that any advance upon that, namely 3.154 after deducting the 1½ lb. back pressure, would be an advance upon perfection. Put it in another form. Say Mr. Smith is intrusted with 3398*l.*, and gives in the following account of it:

	£
Paid away	3320
Own salary	254
	3574

I would say that his management had exceeded perfection to the extent of 3574*l.* − 3398*l.*=176*l.*, or one-sixth of 1000*l.* And this is exactly what is stated about these engines. The 1½ lb. back pressure is part of the account rendered for the steam used, it is the 254*l.* which is stated to have been paid in addition to 3320*l.* out of 3398*l.*

Then Mr. Smith states that it is entirely a matter of *opinion* where it is best to measure the quantity of steam used each stroke. Now, I give it as entirely a matter of *experiment*. I say, "To get this, we must measure the steam before any of it disappears from the diagram, and the best point to take it at is a little before the exhaust in the high-pressure cylinder: generally, but not always, there is a difference between the actual terminal in low, and that due to the volume of steam shown on the high card. We should, therefore, in every case, try what the high will give us, and use it if in excess of the low terminal." I think this is plain; the best place to measure the steam before any of it disappears is a little before the exhaust is high; compare this with what is shown in the low, and use the one that is greatest.

It *is* a matter of opinion, but only of *one*, there cannot be two opinions about it. To illustrate the principle, say you want to know how many coats are made out of a given quantity of cloth by weight. The information is wanted as a test of the economy of the cutters. I would find the quantity of uncut cloth required for each coat, and divide the total weight by that. But Mr. Smith says, the proper way is to take the weight of cloth in a finished coat, and to use that as a divisor. The steam in the high cylinder is the uncut cloth, that at the end of the stroke is the cloth minus all the waste. No doubt this method would



promise a great many more coats than the other, but it would be only a promise. So with Mr. Smith's coefficient. He begins with weight equal to 339 finished coats; he cuts off a strip the whole length of the cloth equal the weight of 25, and out of the remainder claims to have made 332. I maintain this is an advance upon perfection. I say he is making only 255, and that the rest is waste.

Mr. Smith then refers to several circumstances that would tend to show more steam at the end of low than before the exhaust of high. But he in this forgets that he is not defending the measurement of a terminal pressure in low, that is in excess of that due to the high exhaust, but the reverse, and he should rather introduce such facts as would justify our taking the terminal in low as a measure of the quantity of steam used each stroke, although that be less than is shown by the high-pressure card in the proportion of 4.875 to 0.125. I have clearly stated that that measure is to be taken which shows the greatest quantity of steam, *wherever* that may be found.

He then states that my method "cannot be used to challenge the accuracy of the other method." I am not aware of two methods being under discussion, unless how to do a thing be one method, and how not to do it the other. I feel grieved to see a good thing not only rendered useless, but actually perverted to be a great evil. You say, in your article, "This coefficient gives an excellent measure of the quantity of work derived from the use of a given quantity of steam, and we should like to see it universally used as a means of comparison by builders of engines of all classes." And if Mr. Smith's way of arriving at the coefficients be continued, I advise competitors to improve their coefficients by making their low-pressure cylinder barrel-shaped, to have about a quarter of an inch more diameter in the middle than at the ends. Or, if they would like a still higher coefficient, let them make the low cylinder all through, say, ½ in. larger in diameter than the piston. This is sure to give excellent coefficient instead of 3.32, which is now set forth as such a very satisfactory result; the coefficients might in this way be increased to 6 or 10, or more, if approved of.

Mr. Smith then says, that as compared with mine, "this method is fully as convenient for obtaining comparative coefficients of efficiency." I think I have shown that it is indeed VERY CONVENIENT.

He next says: "The difference between the coefficients as obtained by the two methods has been much overstated by Mr. Gray. Thus, if instead of using the rough rule of pressure × volume as constant, he had taken the presumably correct formula for dry saturated steam expanded in jacketted cylinders, &c." I ask the reader to reflect on what we are seeking; it is a measure for the quantity of steam actually used each stroke, the measure of what we pay for the work of each stroke. To get this, we should measure the steam either unexpanded or expanded without loss of energy, otherwise the work or heat abstracted will not be included in one measure. For this purpose the law of constant products is not a *rough rule*, but is almost absolutely correct; it is nearer the truth than is any other expression we have for any phenomenon in the whole range of our knowledge of the properties of steam. It is absolutely true for gaseous steam. The other formula is that the pressure falls below that due to constant products, when in expanding there is work done, and in a jacketted cylinder, and with dry saturated steam, the pressure is less in the proportion of one to the sixteenth root of the degrees of expansion. The sixteenth root of eleven is 1.1617. And therefore by this formula the pressure, when expanded eleven times, is 16.17 per cent. higher when there is no work done by expansion than it is when there is work done during expansion. I say the higher pressure is our standard of measure not the lower one. This rule is not by any means so exact for its purpose as is the law of constant products for free expansion without loss.

To take the lower pressure as our measure would be taking the area of cloth in a made coat, and without the 16.17 per cent. of scrap as a measure of the quantity of cloth to be purchased for a coat.

Mr. Smith, after making out a coefficient in this way 2.95, claims an allowance for a loss in the clearance and ports of low-pressure cylinder. But in what sense, then, are we to accept of the coefficient as "an excellent measure of the quantity of work derived from the use of a given quantity of steam," if part of the effect is to be the addition of a loss? Get the allowance by removing the defect. But surely Mr. Smith does not seriously propose to add this loss as efficiency. He claims that his method of calculating coefficients is fully more convenient than mine, and if convenience be the first merit of a system of steam coefficients, I commend Mr. Smith for his daring originality in including in his method the addition of a loss for the rectification of a coefficient of efficiency.

He concludes by stating that he has accounted for more than half the difference found by me. I ask him now, frankly, to admit that even to the last decimal place I have established all my statements.

I think I have dealt with every sentence in his letter, and that I have proved every one of them to be erroneous; but if there be one sentence that I have overlooked, or one that Mr. Smith thinks he can still defend, I shall be glad if he will point such out to me for further treatment.

Yours very truly,

J. McFARLANE GRAY.

12, Montenotte, Cork, October 3, 1871.

STEAM ENGINE COEFFICIENTS.

TO THE EDITOR OF ENGINEERING.

SIR,—It appears to me that Mr. Smith is wrong in calculating the expansion of steam in compound or other engines by dividing the initial pressure by the terminal. So many causes may tend to the variation of the latter pressure that it can never be fairly used for calculating the expansion. Wire-drawing the steam passing into the large cylinder will partly cause a fall of terminal pressure; for although the pressure in receiver should then increase sufficiently to prevent this it will hardly do so on account of reaction from the receiver. An unjacketted low pressure cylinder will also much vary the terminal pressure, and I may say also the speed at which the engine is driven. The late Mr. Elder expressed the opinion (as I think Mr. Smith knows) that the coefficient obtained by dividing initial by terminal pressure was only fair for engines making the same number of revolutions, per minute, as in fast engines there was always less time for re-evaporation of any water formed in cylinder at commencement of stroke, so that a fast engine would give a higher coefficient than a slow one, that is, fast as regards number of strokes in the minute, though both had the same piston speed. The only fair way of calculating the expansion is, it appears to me, to take the capacity of low pressure cylinder (including clearance and steam port) divide by capacity of high pressure cylinder filled before closing of port (also including clearance and steam port), multiply the quotient by the initial pressure in high pressure cylinder and divide by pressure in high pressure cylinder at point of cut off, the theoretical coefficient may then be calculated from the result, and should always be used as the denominator of a fraction whose numerator is the coefficient found as usual. It is only in this fractional form (or reduced to decimals) that the coefficient has any value, as engines expanding a large number of times will always give a larger one than those expanding a small number of times, although the latter may take more work out of the steam than the former, if the distribution of the steam in the former is not as good as in the latter. For example: An engine having cylinders 6 : 1 and cutting off at one-third in high pressure and having nearly full steam in low pressure cylinders, would probably give a higher ordinary coefficient than one having cylinders 3 : 1 and cutting off at half stroke in both cylinders; as the expansion in the one case would be 18 times and in the other 6 times only; the latter would, however, give a higher fractional coefficient as the distribution of the steam is more nearly perfect.

Yours truly,

London, October 3, 1871. J. J. C.

PROPERTY IN INVENTION.

TO THE EDITOR OF ENGINEERING.

SIR,—My letter in yours of the 22nd of September was not intended as a dissertation on the "rights of inventors," but as an expression of dissent from the tone and tendency of your leader under that title. I cannot wonder, therefore, at your complaint of obscurity.

Neither can I compliment you on any special effulgence shed by your leader on the other abstruse phase of the question, namely, "Property in Invention."

If you will permit me space I will pursue my commentary on your leader, with as much brevity and clearness as I can command.

1. You say, "The opponents of the existing law may be divided into two classes," which are distinctly named. I claim the existence of a third, who, desiring that inventions should be recognised, and the inventor rewarded, deny that the means exist to accomplish this with certainty. And that there is no adequate plan before the world that offers the slightest solution of the difficulty, and who entertain grave doubts whether it is within the limits of possibility to reach the true source of invention or the seat of merit. A halting succession of "pitiful expedients" are trooped out by the tinkerers of the present system. And measures lame and impotent come from those in search of substitutes, and there seems nothing but chaos in the labours of friends and foes, and patent rights rendered the most intangible of property.

2. The notion "that the modification of a needle is as much deserving of protection as the invention that revolutionises a nation's industry" only complicates the case. If modification is to be regarded as of the nature of invention, and vested interest recognised, who shall determine where the result of daily routine ends and ingenuity begins? In the mechanical world modification and application is incessant, and the daily successes of coercing means to an end would shame the thousand "frivolous and vexatious" patentees to blush, if blood formed an element of their composition. You speak of those "worthy inventors who labour meritoriously and usefully, according to their abilities, for their own benefit and that of the public." Is not all labour in such direction induced by the hope of rendering public service, and securing personal gain, and therefore meritorious? Who shall decide, or who can decide, with equity, what is vexatious and frivolous, and what is useful? Can the lawyers? Is legal scrutiny, with its embargo of clashing interests, an ordeal out of which impartial arbitration or justice, "pure and undefiled," can spring? It is not within the compass of human experience to say what is property fit for protection and what is not, if modification is to assume the legal proportions of invention. Even with distinct invention, who can gather all the intermediate links that lie between the pioneer and practice, or, in gathering them into a perfect chain, can say where the chief merit of the combination lies? Nay, it is more than probable that the patentee neither knows its antecedents, nor cares to inquire into the long process of development, but looks alone to the claim he has set up, and which the law may rear into property without regard to its honesty or propriety, providing the legal formalities know no flaw. This is fact of frequent occurrence; it cannot be deterred; and of what use to ingenious men is a law that proffers reward in theory and disappoints in practice?

3. Reform in administration. Would it not be well, in order to avoid "obscurity," to mention what are the "favourable points" of the patent laws you would commend for retention. This might form tangible ground for discussion. The question of inventors' rights and property are in themselves so shadowy, that nothing but vague speculation can attend their entertainment. That in the abstract special reward for special service seems right, there is none to doubt. But to realise the application of so gracious a purpose is something difficult. To give perfect embodiment to "means in supposition" is the rub; claims are abundant, and unsubstantiated assertion waits upon the best, then who shall decide, and say, that justice has not been pushed from her stool?

Can you reform a law that custom and long practice has cut out grooves for it to run in without regard to right or reason? Can you reform that which in its constitution embraces the practice of error so direct and clear as to confer the privilege of property to those whose claims were founded on legal trickery? That which no one can grasp or drill into useful shape; the distinct existence of which can hardly be traced, certainly not tracked, and the only reality of which is its eccentric practice, that baffles the predictions of the most profound, and tumbles out issues that stagger the astute. I know it can wrench the right of invention from the first and true inventor. I have seen it set ruin in the path of struggling gifted merit, that would have known no care but for its luring perils. I have seen it ignore property, where the claim was founded on demonstrated merit, recognised by men distinguished in the annals of science and practice, but blinking justice hoodwinked by legal dust, placed barriers in the path that led to profit. I know of no good that has not been purchased at a cost that is a scandal to our jurisprudence.

And were it not for capital satisfying the avarice of the law, invention would be but little heard of; merit would plod to its legitimate height without the fostering care of capital that often makes a needy genius stoop, "that thrift may follow fawning." Can anything be further from the line of rectitude than that which disappoints hope, crushes expectation, divests right and invests wrong, renders ruin hopeless and irredeemable by its false pretences and fictitious judgments? These are the festering evils of its baleful labours. And this you think there is but a remote chance of moving. Is it so? Was the knell of its prolonged existence not rung in those withering speeches of Lord Stanley, now Earl Derby, and Sir Roundell Palmer? Did not the statement of the Premier that a large capital was constantly and profitably employed in filching patent rights from weak inventors, forcing infringement where capital was wanting, and driving them into the vortex of a law in which dishonest practice found protection? Are Ministers so utterly impervious to truth, reason, and justice as obdurately to resist their loud demands? Was not their silence ominous? I as firmly believe that such unmixed inequity as Parliament unfolded must yield to the purging influence of public scrutiny, as I believe in truth. Your simile of the seeds is good, but wants extension. Were it clear that none reaped other than had sown, there would be an end of all contention. But one sows, several cultivate, a thousand influences aid maturity, and some smart tactician spots the lot. This is the practice—the theory belongs to the region of "airy nothings without habitation or name."

I am glad you lend your powerful pen to scatter the pretensions of idealists who claim "divine right" for inventors, though I think your leanings scarcely less chimerical. There is in your article a world of speculation without a sign of the practical; this is the precise character of all attempts to embody shadows; and I must say the difference between obscurity and inutility is not startling.

The paper of Mr. Wise which I alluded to in my "unpractical" letter was the one read before the Society of Foremen Engineers. In declining to sign my name, I adopt the common course of the "fourth estate," and which is claimed as a source of strength.

To Mr. Pollock I beg to say I do not deny the right for him to sell his apples; but I deny the right or justice of the law to give his apples to another, and allow him to pocket their proceeds. He agrees it is wrong to give public money for a private end. Then it is wrong to sustain monopoly at the cost of the State.

Again, I would not kill a man because he was incurable, but I would not hack his body in the vain hope of removing cancer at the heart. CYCLOPS.

October 2, 1871.

[We regret that "Cyclops" failed to see any "sign of the practical" in the article he criticises. But the fault is not ours. Probably he has not read it aright, at least we judge so from the first quotation he makes, and nothing like which appeared in the article. If, then, he read the whole in the same distorted manner, what wonder if the result was uncertain and shadowy?—ED. E.]

INDIAN PUBLIC WORKS DEPARTMENT.

TO THE EDITOR OF ENGINEERING.

SIR,—Allow me to draw the attention of such of your readers as may be interested in the above department to one of the rules which does not appear so generally known as it should be.

I have been upwards of three years in the service and have just found it out, being like many others too pleased at obtaining an appointment to read the rules very carefully. I would especially commend it to the attention of young men now entering the new college and who work hard, hoping thus to be able to retire the earlier.

The following is the rule:—Periods of service before the age of 22 . . . . shall not count towards pension." "Service reckons from the first day of the 23rd year."

I am, Sir, your obedient Servant,

A MEMBER OF THE P. W. D.

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NOTICE TO AMERICAN SUBSCRIBERS.

In consequence of the great increase in our American connexion, we have found it necessary to establish a branch office in the United States. Communications may in future be addressed to MR. GEORGE EDWARD HARDING, C.E., *of* 176, *Broadway, New York, who is our accredited representative.*

In answer to numerous inquiries, MR. CHARLES GILBERT *begs to state that subscribers in the United States can be supplied with "ENGINEERING" from this office, post free, for the sum of* 1*l.* 14*s.* 8*d.* ($8.32, *gold*) *per annum, payable in advance.*

CONTENTS.

	PAGE		PAGE
The Vienna Exhibition	216	Powder for Heavy Artillery	226
Literature	216	The Great Australian Telegraph	226
Mechanical Refinements	216	Indian Coal	226
Danks' Squeezer for Puddled Balls	217	Round Oak Iron Works	226
Notes from Paris	218	Notes from Cleveland and the Northern Counties	226
Foreign and Colonial Notes	219	Notes from the South-West	227
On the Application of Water Pressure to Machinery	219	Notes from the North	227
A Professional Vision!	219	Guinotta's Expansion Gear	228
American Patent Legislation	219	Mouat Patents	228
Danks's Puddling Furnace	220	Page's Tramway	228
Steam Engine Coefficients	221	Moore and Head's Hoisting Pulley	228
Indian Public Works Department	222	Selenide Mortar	229
Property in Invention	222	Random Notes, from Northern India	229
Burning Coal Gas	223	On the Use of Pulverised Fuel	230
The Fairlie System	224		

ENGINEERING.

FRIDAY, OCTOBER 6, 1871.

BURNING COAL GAS.

ALL consumers of gas—and in these days the name of such consumers is legion—would do well to take to heart the teachings of the first report on the construction of gas burners made a short time ago by the Gas Referees to the Board of Trade. It is not long since we directed attention in these pages to the results of the investigation by the Referees as to the effect of temperature on the illuminating power of coal gas; but the facts of which we propose now to speak possess a more general interest, referring as they do to the vast waste of gas which is annually caused simply by the employment of defective burners. Nothing is more common than to hear both in offices and private dwellings complaints as to the inferior light given by the gas, and we may add that nothing is more rare than to find that the fault lies with the gas itself. In quite ninety-nine per cent. of the cases where such complaints are made, the indifferent light is due, not to the gas, but to the imperfect appliances for consuming it. In 1869, when the Gas Referees were carrying out investigations relating to the choice of a standard burner they made some startling discoveries concerning the defects of the burners ordinarily supplied by very many gas-fitters, while at the printing offices of two daily newspapers it was discovered "that the burners chiefly in use were so defective that they gave out only *one-half* of the illuminating power of the gas actually consumed;" while several of the burners tested gave only *one-fourth* of the proper light due to the gas. That these were not exceptional results we shall see presently when we speak of the performance of different burners under different conditions.

Nor is the loss of illuminating effect the only bad result attendant upon the employment of imperfect burners. Besides the direct waste of gas, and consequently of money, which their employment involves, inferior gas burners by causing an imperfect combustion of the gas have an unhealthy influence, particularly in apartments or buildings where the means of ventilation are imperfect; while in consequence of the reduction they cause in the illuminating power a greater number of jets have to be used, and a larger quantity of gas consumed to obtain a given illuminating effect, and consequently a greater amount of carbonic acid gas, sulphur impurities, &c., are mixed with the air of the apartment in which the gas is burnt.

Under these circumstances, it was evidently desirable to have reliable information concerning the different light-producing effects of gas burnt under various conditions, and this information has been obtained by the Gas Referees, and is furnished by them in the report we have mentioned. For a long time past there has been a doctrine received with more or less faith by gas engineers that gas, when consumed in large quantities, gives a greater proportionate amount of light than when burnt in small quantities. In America especially this doctrine has been greatly believed in, and Mr. Farmer, the photometric observer of the Manhattan Gas Company, has advanced the principle—generally known in the United States and elsewhere as "Farmer's Theorem"—that the illuminating power of the gas increases in a geometrical ratio as the square of the quantity of gas consumed. According to this theorem, if the consumption of 2 cubic feet of gas per hour gives a quantity of light represented by 4, the consumption of 3 cubic feet will produce a lighting effect represented by 9, and so on. The results of the experiments made by the Gas Referees have been such as not only to entirely upset this doctrine, but to show that, with fishtail and batswing burners at all events, there is no constant increase of *proportionate* illuminating effect with an increase of the consumption of gas. Of the results obtained with argand burners, we shall speak subsequently.

We may mention here that during their experiments on various burners the Gas Referees adopted as a standard for comparison the illuminating power given off by a Sugg's No. 1 London argand burner, when consuming 5 cubic feet of gas per hour. This illuminating effect was reckoned as 100, and the light-giving power of other burners was calculated, with regard to this standard and the figures of merit determined accordingly, due regard being, of course, paid to the quantity of gas consumed per hour. In fact, the actual observed illuminating effect of any burner was, for the purpose of obtaining the figure of merit, multiplied by a fraction of which the numerator was 5 and the denominator the number of cubic feet of gas consumed per hour by that particular burner. For instance, if a burner consuming 4 cubic feet per hour gave an observed illuminating effect of 60, the figure of merit would be $60 \times \frac{5}{4} = 75$, and so on. Six fishtail and two batswing burners were tested and the results obtained in every case showed that, although there was a progressive increase in illuminating power of the jet as the quantity of gas consumed per hour was increased up to the point at which smoking commenced, yet that the *proportionate* quantity of light produced attained a maximum at a point far below the greatest rate of consumption, and that beyond this point it steadily decreased, this result being in direct opposition to the very generally received doctrine to which we have referred. Thus in the case of No. II. fishtail burner, which was tested at seven different rates of consumption, and which we have taken as an example, because it appears to have been a fair average specimen of the burners in general use; the results are recorded in the Table in the next column.

In this case it will be noticed that the maximum economical efficiency was attained when the burner was consuming per hour about $\frac{1}{3}$ths of the quantity of gas which gives the maximum light, while in two other instances the maximum proportionate effect was obtained at a consumption of about $\frac{1}{4}$th of that giving the maximum illuminating power. These facts show that it is important to know at what rate of consumption any given burner affords the greatest amount of light in proportion to the gas consumed, as upon this should depend, in a certain degree, the choice of the number of burners employed to produce a given lighting effect. The experiments of which we have just been speaking showed, also, the great variation in the efficiency of different burners, the maximum figures of merit obtained for the six fishtails being respectively 36.0, 62.0, 52.0, 47.0, 19.0, and 73.0, while for the two batswings they were 86.4 and 82.2. One of the fishtails thus gave out but 19 per cent., or less than *one-fifth* of the light procurable from the gas by the use of a proper burner.

Table showing the performance of No. II. fishtail burner at various rates of consumption.

Pressure of gas as delivered to burner in inches of water.	Consumption of gas in cubic feet per hour.	Actual illuminating power: Sugg's London Number 1, at 5 cubic feet per hour, taken as 100.	Illuminating power, calculated to 5 cubic feet: Sugg's London Number 1 being 100.
0.1	1.7	19.1	54.8
0.2	2.8	30.7	56.0
0.3	3.1	38.4	62.0
0.4	3.6	44.3	61.6
0.5	4.1	48.7	58.7
0.6	4.6	57.5	56.0
0.73	5.2	55.9	53.2

With argands a similar variation in the effectiveness was discovered, but the results were on the whole better. The experiments made with four argands—of which the first was Sugg's London argand No. 1, while the second and third were ordinarily good burners, and the fourth was described by the Referees "as one of the worst argands we have met with"—the maximum figures of merit were, respectively, 100, 78.8, 77.4, and 34.3, this latter result being barely over *one-third* of that afforded by Sugg's burner. With the above argands we may remark it was found that there was in all cases an increase in the figure of merit as the rate of consumption was augmented, this increase continuing up to the point at which smoking commenced. At first sight this might appear to be a partial confirmation of the theory to which we adverted in the early part of this article; but further experiments disproved this. These further experiments were made with Sugg's London argands Nos. 0, 1, 2, and 3 respectively, when the maximum figures of merit obtained were 108.5, 107.6, 92.6, and 91.1, while the corresponding rates of consumption were, respectively, 5, 5.5, 7.2, and 7.8 cubic feet per hour. In this case it will be seen that the highest economic efficiency was attained by the burner consuming the smallest quantity of gas per hour, and altogether the Referees arrive at the conclusion "that the illuminating power of gas remains the same, in whatever quantities the gas is consumed, provided that the right kind of burners be employed in the experiments." This latter is a most important point, and one to which consumers should pay attention. It may be noticed here, however, that some burners allow of a far greater range of rate of consumption than others without any vast loss of effect, and in this respect Sugg's argand burners give particularly good results.

An important element in the attainment of a good light from gas is that the air supply should be properly proportioned to the quantity of gas consumed. In the case of naked burners, such as batswings and fishtails, the supply of air depends greatly upon the velocity of flow of the gas from the burner, an increase in this velocity being accompanied by an increase in the air supply, and *vice versâ*. In the case of the classes of burners just mentioned, a certain amount of pressure is necessary to give the proper shape to the flame, but beyond a certain point increase of pressure is most decidedly deleterious, and is a certain source of waste, as it causes the air supply to be in excess, and causes a diminution of the illuminating effect.

In argand burners, as very commonly constructed, an excess of pressure beyond that which is otherwise desirable, is but too often necessitated in order to get the required quantity of gas through the burner, but in Sugg's argands means are provided to check the pressure as delivered to the burner, and the results are most satisfactory. In the argand the chimney affords a special means of regulating the air supply, and it is, in fact, owing to the controlling effect of the chimney on the amount of air which can reach the flame that the quantity of gas delivered to an argand can be increased so as to produce smoke. By turning to account this con-

trolling effect of the chimney, a burner constructed to consume effectively, say, 5 cubic feet per hour can, in a very simple manner, be made to consume, with very fair efficiency, a far less quantity, and some interesting experiments were made on this point by the Gas Referees. The burner used in these experiments was Sugg's London argand No. 0—a burner which the Referees describe as "the very best yet constructed"—supplied with gas of 15-candle power. The air supply was adjusted by placing a metal disc above the upper end of the chimney, and the results obtained were as follows:

Pressure of gas.	Consumption per hour.	Figures of merit for illuminating power	
		without disc.	with disc.
in.	cub. ft.		
0.064	1.65	7.36	63.5
0.076	2.05	15.2	90.1
0.1	2.4	30.7	93.3
0.2	3.9	88.5	101.0
0.25	4.5	103.9	smokes
0.27	5.0	109.6	smokes

It will be noticed from this summary that when the rate of consumption was far below that for which the burner was constructed, the application of the disc had a most marvellous effect, the figure of merit being in fact with the lowest rate of consumption increased nearly *ninefold* when the disc was used. It is to be remarked, however, that in no case did the disc enable a higher efficiency to be obtained than was procurable from the burner without the disc when the rate of combustion was that for which the burner was suited, and we mention this fact because we know that in some instances peculiar merits have been claimed for discs *per se*, quite irrespective of the real fact that their usefulness consists in their enabling the action of a burner to be modified to suit circumstances for which it was not specially intended.

Besides its being essential that the supply of air should be correct in quantity, and that the gas should escape from the burner with the least practicable pressure, it is also desirable that the supply of gas should be equal to all parts of the flame, and that the flow should be even and steady, any "roaring" or swirling motion of the gas being attended with a loss of illuminating effect. The length to which the present article has extended, however, prevents us from saying any more on these points of detail. It has been our object on the present occasion merely to direct attention to the great loss attendant upon the employment of imperfect appliances for consuming gas, and to speak briefly of some points upon which the effective consumption of gas depends; but at an early date we hope to return to the subject, and treat, in greater detail, of the peculiarities of gas flames, and of the practical means of burning gas with the best economical results.

THE FAIRLIE SYSTEM.

It is now nearly five years since Mr. C. D. Fox read a paper before the Institution upon the Queensland Railways, in the course of which the Fairlie engines which had just been built for that line were fully described. The subsequent history of these locomotives is well known; how they arrived duly at their destination, and how, after partial tests, which were, to say the least of it, incomplete, results were arrived at entirely opposed to those from the trials which had been conducted with them before they left England. Condemned upon the alleged failure of one of these engines, the others were never taken out of their packing cases, and after lying for some years in the colony, they were reshipped to England, where they now are awaiting sale. For the sake of the prejudiced persons who thus condemned these engines, probably the less said the better; the affair was not a creditable one, and though doubtless their condemnatory report resulted in the postponement of the introduction of the Fairlie engine in Australia, the effects of this report are rapidly dying out, and at the present time there appears every determination, with a few unimportant exceptions, at least to do justice to the system.

It is worth noting how entirely the course of events is justifying all that we have said upon this system from first to last, and it is satisfactory to find that, as in Australia, so over all the world, prejudice is fading out, and is being succeeded by a desire to subject to the test of experience, under the most varied conditions, the opinions that have been strenuously advocated by the inventor for so many years. In almost all parts of the world where railways exist, and upon almost every gauge that has been laid down, Fairlie engines are already running, or will shortly be at work, and we have now simply to wait until sufficient time has elapsed, to test the real efficiency of the principle under every condition of work, to ascertain exactly how much may strictly be claimed for it, and how much sanguine anticipation has fallen short. For our own part we have little doubt as to the result, being fully convinced that events will show that all that we have ever claimed for the system, will be performed by it. But besides the significant fact that wide-spread opinion has almost simultaneously declared itself in favour of fully testing the Fairlie engine, it is to be noted, as a most fortunate circumstance, that the most favourable conditions possible are now obtained for the construction of the engine. Many of the principal engine builders in this country are actively engaged upon making them, so that the faults in construction which have been seen in some of the earlier, and as it were experimental engines, to their great misfortune, will not be repeated. That such firms as Messrs. Sharp, Stewart, and Co., the Vulcan Foundry, the Avonside Engine Company, and others, are engaged upon the work, is a sure guarantee that all that is possible will be done in the way of good design in detail, and perfection in workmanship, so that for the future the Fairlie engine will stand or fall upon its merits, uninfluenced by any question of faulty detail or indifferent workmanship. We are particular in pointing out this fact, because we do not think sufficient allowance has ever been made for these things, and because the various builders now at work appear determined to do all that lies in their power to insure a complete success. At the same time it should be borne in mind that even during what may be called the experimental stage, the Fairlie engine never made a failure, despite the Queensland allegations; it has, however, undergone the various progressive improvements inseparable from the development of any new machine, and as at present it takes its place on the same footing as other engines in the shops of the manufacturer, it enjoys many advantages denied to it before it entered upon this new and vastly extended phase.

Until the visit of the Russian Commission to this country, but little practical success had attended all the efforts made by Mr. Fairlie to overcome the prejudice existing against his engines, and to obtain a fair hearing for the principles he advocated. A few exceptions, however, have to be made in the general opposition he steadily encountered. Especially should be mentioned Mr. C. E. Spooner, engineer of the Festiniog Railway, with which the public has become almost saturated of late; this gentleman, possessing no prejudices or party spirit, saw at once the great advantages to be derived upon his line by the use of the Fairlie engine. He accordingly lost no time in practically, and of course most successfully, testing the value of the system. The results of this action are told in the increased capacity of the little line, the saving of capital that would otherwise have been required for doubling it, and the increased and economical duty performed by the engine. To these facts we need not refer; they have been published and circulated until every one is familiar with them, even to the uttermost ends of the earth. But we may safely assume that, had Mr. Spooner held aloof, and followed the example almost universally set him, the Fairlie engine would not be manufactured to-day in nearly all the principal shops in the country. For the decisions of the Russian Commission were based entirely upon what its members saw in Wales, and the action they took has encouraged similar action over the world. So that, as we say, Mr. Fairlie may thank Mr. Spooner for helping him to the advanced stage at which he has arrived to-day.

So rapid has been the progress since that time, that whereas before, the number of engines that had been built to order might almost have been counted on the fingers, there have been, since May of last year, no less than fifty-five engines delivered, built, or in course of construction. In the history of railways we cannot find a parallel case to this, and we believe that no other engineer, unconnected with railways, or with manufacturing establishments, has ever achieved such a success in so short a space of time, despite the difficulties to be overcome, and we cannot but see in it a striking proof of the advanced spirit of railway engineers abroad who have shown themselves strong enough to break through the bonds of precedence, and adopt what promises to be an element of great commercial value to the lines with which they are interested.

We have always pointed out that there exists an unlimited field for the Fairlie engine. In new countries the construction of railways especially those of narrow gauge, and the conditions which rule the traffic, are especially favourable for its employment. In the former we have, for the most part, cheap lines, with sharp curves and heavy gradients, and light permanent way; the Fairlie engine can travel round the quickest curve ever laid, is admirably adapted for heavy gradients, and distresses the rail but little, because its weight is so much divided. With regard to the traffic conditions, as a rule quickness of transit is of less importance than economy. Hence, heavier, but fewer trains may be run, to the obvious saving of engine, rolling stock, and permanent way, provided that the locomotive employed be sufficiently powerful; and as the Fairlie engine is independent of gauge, loads equal to the maximum that can be carried on the ordinary width, can be easily conveyed on the reduced gauge, whilst, as a matter of course, the capacity of the former worked on this system is proportionately increased.

Out of the twenty Fairlie locomotives now being built by the Avonside Company, at Bristol, for various countries, and for widely differing gauges, one was placed under steam, and tried last Friday, previous to her being shipped for Peru, where she will run upon the Iquiqui Railway, already partially stocked with the Fairlie engines. The gradients and curve of this line, it will be remembered, are extremely heavy, there being 11 miles of 1 in 25, combined with curves of 3 chains radius.

This engine, the "Hercules," has a total weight of 60 tons, supported on 2 bogies of six wheels each, and the cylinders are 15 in. diameter and 22 in. stroke. On Friday, during her limited trial, she behaved exactly as all the Fairlies do behave—that is, she ran round curves inaccessible to any other locomotive, and traversed a length of execrable road with perfect steadiness. Indeed, this was the only feature of the trial worth noting; for whilst the permanent way leading from the company's shops, and belonging to the Midland Railway, was almost too bad for anything to run upon, the motion on the footplates was scarcely perceptible, although the bogies were in a perpetual state of agitation that would have been violently felt upon any ordinary engine. In passing round one of the yard curves the play of the bogies on each side of the boiler centre line was 7 in. The excellence of the workmanship and the careful finish of the engines in progress at their works is worth noting, and much is due to Mr. Alfred Sacré for the energy and spirit he has put into the establishment. Amongst the locomotives that gentleman is now building are some for a 2 ft. 6 in. line in Peru for the conveyance of nitrate from the mines to the coast. These again are for working over long and steep gradients of 1 in 20, with ruling curves only 2 chains radius.

In addition to the twenty locomotives, a large amount of rolling stock is being built at Bristol, comprising all the main features of Mr. Fairlie's system as already described and illustrated by us. It is being built by the Bristol Wagon Company, and includes rolling stock for 4 ft. 8½ in., 3 ft. 6 in., and 2 ft. 6 in. gauges. None of the wagons, however, are being built strictly to embody the principles laid down by Mr. Fairlie with regard to subdivision of load, and to the profitable proportion of dead to paying weight for general traffic; this arises from the fact that the stock has been built to order so far as its general dimensions for capacity are concerned, and is to a great extent intended for a service in which full loads can always be depended upon in one direction. But although the capacity is large, the stock is wonderfully light: thus the 4 ft. 8½ in. wagons are 14 ft. long by 7 ft. wide, and 2 ft. 6 in. high, all inside dimensions; they weigh 45 cwt., and carry 7 tons. Those for the 3 ft. 6 in. gauge are especially large, having also a capacity of 7 tons, and a weight of 42 cwt. The smallest of all, for the 30 in. gauge, are 6 ft. by 12 ft., and

2 ft. 6 in. deep; they carry 5 tons, and weigh 31 cwt. The underframe of all these wagons is identical in arrangement, being formed of composite side beams, of iron and timber, with transverse bolts, and timber bracing well arranged. Central buffers are employed with stiff springs and a very short play; the heads of the buffers are curved with a radius struck from the centre of the pin, around which the radiating coupling rods turn; by this arrangement it is obvious that the buffers are always kept in contact in passing round a curve. The coupling arrangement is what we have on a previous occasion described. A long coupling rod hung upon a pin beneath the floor and in the centre of the wagon projects beyond the end frame, and beneath the central buffer, expanding into a pair of jaws, through which a pin passes transversely, actuated by a bell-crank lever at the side of the wagon. The vehicles are coupled by means of a short link, which brings the buffers up face to face. The operation of coupling up a train is performed with the greatest despatch, and without any of the risk not unknown by the present system. A link is placed in the jaws of the coupling rod upon the wagon to be connected with the train, and is secured by the pin being passed through it, and this link, upon the wagon taking its position in the train, enters the jaws of the adjacent coupling, the lever at the side of the wagon is thrown into position, and the coupling is completed by the pin which is actuated from the lever. This is, of course, an operation involving scarcely any time or trouble, and it is certain in its action, the form of the link and jaws being such that the former must always enter, even through the vehicle to which the latter belong, be heavily loaded and depressed upon its springs. To maintain the coupling rods in as central a position as possible in passing round curves, two transverse coiled springs are placed near each end of the wagon, one end of each spring being attached to the side frame, the other to the coupling rod itself; these springs, of course, only come into action in passing round curves, the right or left spring being called into play according to the direction of the sweep. The 3 ft. 6 in. carriage stock is very praiseworthy, both in design and finish. The first-class carriages are 19 ft. 6 in. long by 7 ft. 6 in. wide. They are divided into three compartments, and hold 24 passengers; the fittings are extremely elegant and commodious, and a headway of 6 ft. 6 in. in the centre is secured. The second-class stock is of the same dimensions, except in length, which is a foot less. Each carriage of this class holds 30 passengers. The weights per passenger are 300 lb. and 232 lb. for the two classes respectively.

The whole of the 3 ft. 6 in. stock we have been describing is being made for Messrs. Proudfoot and Oliver, who have ordered it for the Dunedin and Port Chalmers Railroad in New Zealand. These gentlemen undertake the working and maintenance of the line for two years after its completion, and no small credit is due to them for the enterprise with which they have adopted the system in the face of any opposition in the colonies. They consider, however, that the Fairlie engine and stock is better suited for their purpose than any other they can obtain. We think there can be no question as to the justness of their views, and that events will not fail to establish undoubted proof of the soundness of the policy they are following.

POWDER FOR HEAVY ARTILLERY.

The vagaries played by the 35-ton gun when on its proof, as regards pressures and velocities, obliged the committee on explosives to reopen their investigations as to the powder best suited for this piece. They have since been experimenting with gunpowder grained in various ways and made into pellets of various forms and sizes. The most recent results of their investigations, as far as we are at present informed, tend to show that they are approaching, if they have not absolutely reached, the object of their desires, namely, low pressures and high initial velocities. In the early stages of the experiments solid cylindrical powder pellets, ½ in. diameter and ½ in. thick, were used. With these it was found that pressures of 47 tons per square inch were obtained with initial velocities of 1430 ft. per second. It will be remembered that the 35-ton gun gave, with 120 lb. of pebble powder, a similar pressure with a velocity of 1370 ft. With 130 lb. of powder the velocities fell to 1348 ft. Hence with the solid pellets a slight improvement in the velocity was obtained. Cylindrical pellets ½ in. in diameter, ½ in. thick, and having a hole or indent formed on one face ⅛ in. diameter and ¼ in. deep, were then used. The pressures obtained with these pellets ranged from 23 to 24 tons per square inch, the velocities remaining good.

The next step was to split these indented pellets in halves and to glaze the halves in the ordinary way. The results of firing heavy charges with the divided pellets has, we hear, been a reduction of the pressures to 14 tons per square inch, whilst at the same time initial velocities of 1430 ft. per second are obtained. It is difficult to account for this extraordinary reduction of pressure without a knowledge of all the details of the experiments of which we are not at present in possession. It appears singular that these broken pellets which closely approach the nature of pebble powder—except that the grains are slightly more uniform in size and shape—should give pressures so very much below those of the pebble powder with equal velocities. These results are certainly very remarkable, and if repeated trials establish them as indisputable facts and do not prove them to have been so far the result of accident, derangement of the pressure gauges, or miscalculation, a most important advance will have been made towards the settlement of the powder difficulty.

THE GREAT AUSTRALIAN TELEGRAPH.

The intelligence which has recently come to hand with respect to the great overland telegraph, which the South Australian Government is carrying from an extreme point of South Australia to Port Darwin, has not been altogether favourable. Up to July 8, the affair looked very promisingly, but on that day the Government schooner Gulnare arrived at Port Adelaide from Port Darwin, bringing tidings of the collapse of the construction party directed by Messrs. Darwent and Dalwood, and employed in laying down the line from its northern terminus along the valley of the Roper, and thence to meet the various parties working upwards from Port Augusta. The collapse of Messrs. Darwent and Dalwood's organisation is attributed to the action of one of the Government overseers, Mr. McMinn, who became dissatisfied with the slow progress which the contractors were making, and exercised the power confided to him of annulling the contract, with the view of carrying out the work on behalf of the South Australian Government. Mr. McMinn's report detailing his reasons for the step taken by him has not yet been made public, and Messrs. Darwent and Dalwood have been still more reticent as to their version of the case, as they have intimated their intention to appeal to a judicial tribunal to vindicate their real or supposed rights in the matter. Most of the contractors' party returned to Adelaide in the Gulnare, and the South Australian Government had to take the most prompt and energetic measures to make up for the loss of fully three months of fine and cool weather. Mr. Todd and the colonial telegraph department, which has been associated with the Post Office, have been doing their best to meet the difficulties of the case; and by this time strong reinforcements of men, teams, and stores have probably reached Port Darwin, and the work has been resumed. It is not very easy, however, to see how the measure adopted by Mr. McMinn can result in the end in any real economy of time. It is intended, notwithstanding all obstacles, to carry the wire through with the utmost possible speed, and to postpone until afterwards the absolute clearance of the line and the fixing of permanent supports. By this means and by hastening forward the working parties from the Port Augusta end, Mr. Todd still hopes to secure a through connexion by the end of the year, although much will remain to be done before the line can be considered complete.

As regards the other portions of the great line which have been proceeded with without interruption, Mr. Todd had received news from the Peake up to July 12. Mr. Babbage, writing on the 30th of June, states that he had laid out the whole of Mr. Bagot's contract for 514 miles, and at that date the health of the people at work and under his supervision was excellent. He had been as far as latitude 26° 40′, and he was laying out the line as he returned. Mr. Boucant, the sub-overseer of Mr. Bagot's construction party, wrote from Mount Margaret, under date July 3, to the effect that the work was progressing rather slowly, owing to the posts not arriving fast enough to keep the various working parties employed. Only 25 miles of poles had been erected by Mr. Bagot's party in June, and there were yet 150 miles to be fixed, but better progress was expected to be achieved during July. A series of meteorological observations have been kept at the Peake from the commencement of its establishment as a depôt, and from these it appears that the highest temperature recorded in June was 85°, and the lowest 33°. The quantity of rain had fallen off very much, but there had been slight showers. It appears that at the end of June Mr. Bagot's party had wired 150 miles of poles; all the wire had reached its destination and only needed fixing. It was expected that Mr. Babbage would be sent to the northern end of section E, whence he was to take a number of wagons and make a rapid survey of the remainder of the line, tracking it as far as the Roper.

Such was the position of the great Australian telegraph in the second week of July. At the Port Darwin end, work was virtually suspended; in the middle of the great island continent, operations were hardly proceeding so rapidly as could be wished; and only two months of cool weather remained, as the interior of Australia—especially the great open plains—must be given over to great heat in November, December, January, and February. Even in June it will be observed that the meteorological observations made at the Peake depôt indicated a maximum heat of 85°. It seems probable that the experience of August and September will decide one way or the other the fate of the line for the current year. If the hitherto trackless interior can be crossed successfully by the magic wire by the end of October, all may yet go well, albeit that Mr. Todd's expedient of carrying a flying wire over the Port Darwin end of the line seems rather a sorry one. It is obvious that, as the working parties approach the northern coast, their position will improve day by day, but it might go hard with them if they were overtaken by the burning Australian summer, say 500 miles from Port Darwin or Port Augusta. But even if the line should be carried through after a fashion this year, there remains the question of maintenance, and especially maintenance in the summer months. Although the working parties despatched into the interior seem to have fared tolerably well—and better than might perhaps have been anticipated—the fact cannot be gainsaid that Captain Sturt was compelled in the summer of 1846 to retreat from a region which he named the Great Australian Desert, by reason of the intense heat and the prolonged drought. The gallant captain and his companions had, indeed, to flee for their lives back to that very South Australia which has now engaged in the important work to which we have been directing attention. Australian seasons are certainly capricious and variable, and what is true of one year probably does not hold good of another. Still there seems no reason to doubt the tolerably well established conclusion that the interior of Australia is subject to great heat during the summer months, and the maintenance of a telegraph line through this hitherto unknown region may consequently prove a work of very considerable difficulty. The South Australian Government would possibly not have engaged in the construction of the great line but for its Northern Territory venture; but having engaged in it, it has certainly carried it on unflinchingly and without looking back. The prosecution of the work has, at any rate, been attended with the advantage of having added materially to our knowledge of the interior of Australia; and even if the South Australian Government should fail in its courageous efforts, there is still the consolation of knowing that an alternative telegraphic line can be carried, if need be, round the southern and north-eastern coasts—that is through Victoria, New South Wales, and Queensland—of the vast region which has so strangely fallen under the power and influence of Great Britain.

INDIAN COAL.

It is not long since the Chanda coal-fields were first opened, and now we have before us a report upon the trial of coal taken out of the Mayo colliery. From the very friable nature of this coal it is most probable that the present workings are either from an outcrop or from the top or extreme end of the seam, and it may be hoped that better results will be obtained as soon as the working shall have been carried further forward into the bed. In view to a trial of the fuel for locomotive purposes 106¼ tons of Mayo pit coal were sent to the Great Indian

Peninsula Railway at the Wardha Station. It was burned on their locomotives during February and March last, being used chiefly on engines drawing goods and mixed trains on the 108 miles length between Budnaira and Nagpoor. Several sets of fire bars were tried with various spaces between the bars; those placed 2 in. apart being considered by the locomotive foreman to be the best suited for the fuel. During the whole of the trials, the consumption of coal averaged 51 lb. per mile run, that being about 34 per cent. more than the English coal burnt in the same district. There does not appear to have been any difficulty experienced in using it, beyond making an alteration in the width of spaces between the fire bars; it will not, however, stand exposure like the English coal, but requires to be burnt fresh from the pit. The head officer of the Great Indian Peninsula Railway Locomotive Department considers, however, that if a line were made from Wards to the pit, and the coal could be obtained at a reasonable rate, there would be no difficulty in working the Nagpoor branch entirely with it. The goods and other trains hauled by the Chanda coal were of an average length and weight, consisting of from 20 to 24 wagons, weighing with their loads 10 tons each. No wood fuel was used to light up the fires in the engines, but with English coal a certain quantity of wood is generally used. This lighting up with coal made the poundage per mile about 1½ lb. heavier over the 108 miles than it would have been had wood been used for lighting. The consumption per mile of Nerbudda Valley (Mohpani) coal had hitherto averaged 57 lb. per mile, and according to a printed report, dated 11th October, 1869, the average consumption of Raniganj coal was then about 75 lb. per mile on the East Indian Railway line. Thus the duty done by the Chanda coal compares favourably with the fuel both from the Nerbudda Valley and Ranigunj. The cost of the coal was 30s. per ton, at which price Chanda coal proved 20 per cent. cheaper than English coal on the Nagpoor extension. The engine drivers did not like the Chanda coal at first, but after a few trips they became better satisfied with it; and its only drawback seems to have been that this coal, while burning, "threw off a great deal of dust." It is very clear, therefore, that the coal as yet worked in the Mayo pit is of a very soft friable character and not capable of resisting the powerful draught in the locomotive. It is also highly hygroscopic, containing, according to assay, no less than 19.82 per cent. of water; and as this water dries off the coal falls to pieces.

ROUND OAK IRON WORKS.

The Round Oak Iron Works are, *par excellence*, the best designed of any in South Staffordshire; they are handsome in their style, and substantial in their construction, while not only have they a fine outward appearance, but they are built in a manner best suited to the laying out of the internal machinery. The works are the property of the Earl of Dudley, a descendant of the famous Dud Dudley, who was the first to successfully smelt iron with pit coal. The site of the present works is also not far removed from the spot where Dud Dudley carried out his operations. The Round Oak Iron Works are situated at Brierley Hill, about two miles from Dudley, close to the side of the Great Western Railway, whilst at their rear is a canal, so that excellent facilities exist for the transport of material to and from the works. Nearly the whole of the land and minerals lying within a circle of five miles round Dudley are the property of the earl, and it was with the object of utilising on the spot the very rich materials employed in the construction of iron, with which the district abounds, that the present works were constructed. The celebrated "thick coal," ten yards thick, is worked from his lordship's pits, as is also the rich argillaceous ironstone, from which alone the iron is made at these works. The mine is smelted in the blast furnaces, of which there are two extensive plants, and the limestone used as a flux, is obtained from the pits and caverns on the estate. The iron produced here is, for certain purposes, unsurpassed, and it commands a higher price in the market than any other made in the district. The whole of the materials used in the buildings and machinery are raised and manufactured, and the buildings, engines, machinery, &c., were erected by his lordship's own workmen. There are four blast furnaces at the New Level, each supplied with hot air stoves, the blast being furnished by a large condensing beam engine. The blast main has a partition running through its centre, so that it can be used for two separate engines at the same time; it is approached by a circular staircase, and a platform runs the whole length, so that men may have ready access to the valves. The tops of the furnaces are level with the main railroad, which brings the coal and coke from the earl's collieries, and delivers them at the furnace mouths. The limestone and ore are drawn from the canal side up an incline to the top of the furnaces by a beam engine, which also draws the cinders from the falls to the top, whence it is taken away, and tipped down the cinder bank. The Round Oak Works are built in a very substantial manner, of red bricks faced with white, and the eaves of the slated roofs are terminated by cast-iron spouting of a very handsome pattern. The slated roofs, which cover the entire works, are supported upon ornamental cast-iron columns and brackets. The centre portion of the building is occupied by two forges, and on each side of these are the mills; in close proximity to the mills are two extensive warehouses for stocking the finished iron, and these warehouses form the extremities of the front of the works. The boiler houses, three in number, are at the back, whilst in the centre of the front of the works is a neat little building, used as the timekeeper's office. At the back of this office are two forges, having about fourteen puddling furnaces in each. The machinery in No. 1 forge is worked by a large rope band from a pulley on the flywheel shaft of a horizontal high-pressure steam engine, having a 30 in. cylinder and a 3 ft. stroke, placed between the two forges. This machinery consists of a 6½ ton helve, whilst in No. 2 forge is a 6½ ton helve, worked by gearing from an intermediate shaft. There are two forge trains, one standing in each forge, worked from either end of the intermediate shaft above referred to. In each of these trains there are three pairs of rolls with all their necessary appliances. Steam is supplied to the forge engine by five cylindrical boilers, 30 ft. long by 5 ft. diameter, and one boiler placed upon cast-iron columns and girders over a heating furnace, and connected by a flue to the latter. Besides the machinery already named, there is in one forge a very powerful smith's steam saw, which will cut up to 7 in. or 8 in. rounds and squares, and in the other a massive pair of lever shears, used for cropping the edges of the plates. To the 16 in. mill there are three heating furnaces, and to the plate mill the same number, with the addition of a large annealing furnace. A 4-ton Kirkstall Forge Company's patent steam hammer stands at one end of the forges.

Howatson's patent heating furnace has lately been tried here with great success. The speciality of Mr. Howatson's plans consists in his modes of supplying hot instead of cold air to the grates of the puddling and heating furnaces, and he asserts that in one year coal and iron to the value of 187*l.* may be saved in a puddling furnace, and over 450*l.* in a 12-in. mill heating furnace, by the adoption of his system. We are not, however, in possession of sufficiently extensive data to enable us to form an opinion of the accuracy of these estimated savings under a variety of circumstances. The invention is applied to a heating furnace in the following manner: All the ordinary air passages, such as the opening under the grate at the end of the furnace, and the fuel charging place, are covered over; the former with sheet iron, having a sliding door, actuated by a balance weight at the top, which can be lifted to clean the bars; and the latter with a hanging cast-iron door. By this means all air is kept out from the grate end of the furnace, and all necessary for combustion is supplied from the stack end. At the bottom of the stack there is a square opening, and, above, several perforations in the brickwork; through these the air enters, and passes into flues surrounding the base of the stack, where it becomes heated by contact with the flues. It is then conducted down, round the neck of the furnace, into a series of parallel passages, from whence it enters the opening under the fire-bars, and is used at a high temperature for the combustion of the fuel. In order that the gases generated by the fuel shall be thoroughly consumed, and that there shall be no smoke, a flue is made in the walls of the fire grate, opening by means of perforations both above and below the bars. The perforations under the bars are covered with a sort of valve, which can be regulated so as to supply any quantity of air as required over the top of the fire, and can stop it altogether when there is no smoke. A handle attached to this valve is placed in front of the furnace near where the man stands. The application of the patent to a puddling furnace is slightly different, as the cold air is first supplied under the bed of the furnace, which it cools and preserves, and then passes round the base of the stack, along the back of the furnace, and is then delivered in the heated state under the grate. The smoke-consuming apparatus can be applied as in the heating furnace. By an extra arrangement in the puddling furnace, the pig iron is melted in a separate chamber by the waste heat from the furnace. This chamber is built between the puddling chamber and the furnace neck. The charge of pig iron is put into it, and whilst the puddler is manipulating his charge, drawing the balls, and taking them to be shingled, the pig iron is ready to run down into the puddling chamber. With a heating furnace constructed on this plan at the Round Oak Works the following results have been obtained: In one week of ten turns, when a 12-in. mill furnace had got into regular working order, a saving of 5 tons 18 cwt. 0 qr. 17 lb. of coal, 1 ton 2 cwt. 1 qr. 3 lb. of iron, and a loss of 2 tons 8 cwt. 2 qr. 3 lb. of cinder, the decrease in the latter being accounted for by the sawing in the iron. It is also stated that the furnace has worked better, the iron being sooner and more uniformly heated, that the labour of the furnace-men is diminished, as less fire is required, and that there is every appearance that the brick lining will last much longer than is usual with the ordinary apparatus. A puddling furnace has recently been tested at Mr. Thomas Vaughan's Bishop Auckland Iron Works, and there was a saving during the first week it was in operation of 4 cwt. 0 qr. 9 lb. of coal, and 2 qr. of iron per ton of puddled bar made.

The Round Oak new forges, which are situated at a short distance from the other works, have been built about six years, and were erected with the object of making a sufficient supply of puddled bars to keep in advance of the works. The puddling furnaces, 28 in number, are arranged in a semicircle, the engines, forge trains, helves, &c., being placed as nearly as possible about the centre of the semicircle, by which plan all the furnaces are at almost an equal distance from the helves. The forge engines are vertical, and placed side by side, having cylinders 27 in. in diameter, with a stroke of 2 ft. 4 in. Steam is supplied from six cylindrical boilers, 35 ft. long by 5 ft. diameter, which are at some distance behind the engines, and clear of the works. To each engine there is a forge train, helve, and a pair of shears. The cam rings are driven by pinions on the fly-wheel shafts, which work into wheels on an intermediate shaft, and are geared to the cam ring shaft. Each helve weighs 6½ tons. The forge trains are driven from the ends of the intermediate shafts, and two pairs of cutting-down shears, worked by gearing and cranks.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

Middlesbrough, Wednesday.

The Cleveland Iron Market.—Yesterday the quarterly meeting of the North of England iron trade was held in the Royal Exchange, Middlesbrough. The attendance was large but not is numerous as in generally the case at the quarterly meetings. Although there were the usual facilities given for parties wishing to exhibit models and diagrams of interest to the trade, there was only one table occupied by one firm for this purpose. Messrs. Tangye Brothers and Rake, of Newcastle, exhibited Stroudley's patent wrought guide plates or ramps for speedily re-railing rolling stock; Tangye's patent high speed regulating governor steam engine with vertical boiler, the spiral pump, and the patent smoke and heat precipitator for destroying heat and smoke arising from steam boilers in coal mining, &c. A fair amount of business was done, and the market closed at the rates we have quoted for the past month. Every available blast furnace is at work, and the demand is so heavy that a much larger number of furnaces might be kept in full blast.

The Finished Iron Trade.—All departments of this healthy trade are in a good condition. There is still a large amount of work in the rail trade on hand. Owing to the Continental prosperity in the shipbuilding trade, there is still a very heavy demand for plates and angle iron. The wire mills are kept steadily going.

The Ironworkers and Mr. Hughes's Award.—On Monday a very largely attended meeting of ironworkers was held at South Stockton, and the following resolutions were unanimously agreed to: 1. That nothing short of the additional 5 per cent. on the present rate of wages will satisfy the ironworkers of the North of England. 2. That if the ironworkers are to be bound for nine months they claim the 5 per cent. as time bargain. And if the 5 per cent. be not granted they do not consider that they are bound for that period. Arrangements were made for holding another meeting on an early date. It is very unfortunate for the Board of Arbitration, which has worked so well since it was established, that the ironworkers should every now and

again strike or hold meetings of a threatening character. The proper course for the men to pursue when they wish any alteration either in wages, in iron, or appliances, is to instruct their representative or the Board to bring the matter before the Standing Committee. Within the past few days the chairman of the Board of Arbitration and the operative secretary of the Board have written to the *Newcastle Chronicle* allaying expressions of opinion that there is considerable dissatisfaction amongst the ironworkers at present. There is undoubtedly a disposition on the part of a large number of puddlers to ignore the Board of Arbitration. It is to be hoped, however, that the men themselves will do their best to remove that disposition, and explain to their fellow-workmen the advantages of the Board of Arbitration.

The Nine Hours' Movement.—The indications of the unhappy struggle for the nine hours' movement in the engineering trade at Newcastle being terminated last week has resulted in the men making an offer to the masters, which was rejected, and the men have returned to their demand for the nine hours pure and simple. Mr. Burnett, the president of the Nine Hours' League, suggested that the men should accept the proposal of the masters to concede two of the five hours asked for, and purchase the other three from their employers. This suggestion was considered by the men, and, after a vote by ballot, was adopted. The decision of the men was placed in the hands of Mr. Mundella, M.P. for Sheffield, and that gentleman brought it officially before the Masters' Association at Newcastle on Friday. The men having previously arranged for a great mass meeting on Saturday, held that meeting, and they hoped to be able to lay the answer of the masters before it. The masters, however, did not reply in time for that meeting. There were not fewer than 20,000 men at the meeting, which was held on the Town Moor. Speeches in favour of Mr. Burnett's proposal were made, and strong hopes were expressed that the matter might be speedily settled. On Monday the masters replied, rejecting the offer of the men, in terms which will be already familiar to your readers from the publication of Sir W. G. Armstrong's letter in the daily journals. A mass meeting of the men was held on Monday night, and they unanimously passed the following resolution: "That this meeting is of opinion, since our employers have refused the offer of compromise which we have made to them, that it is advisable to stand out until the whole of our original demand is conceded." After a suicidal fight for twenty weeks, the question has assumed its original position. Financially the men are encouraged to hold out for the nine hours, and to agree to no compromise. This week the 1950 strike hands remaining in Newcastle have received 12s. each from the League, and 1s. per child in addition has been paid. From all parts of the United Kingdom the subscriptions flow in more liberally. Many of the foreigners whom the masters have brought from the Continent are returning. The expenses of some of them are paid by the Nine Hours' League.

Puddling by Machinery.—Yesterday the commission appointed by the Iron and Steel Institute to visit the United States for the purpose of obtaining information on the working of Danks's rotary puddling furnace were to sail in the City of Baltimore for New York. The gentlemen constituting the commission are Mr. J. Snelus, Dowlais; Mr. John Lester, Wolverhampton; and Mr. John A. Jones, Middlesbrough. They have taken with them a quantity of Cleveland pig iron for the purpose of making experiments with the puddling furnace.

Shipbuilding.—Beyond the fact that all the shipbuilding yards on the Northern rivers are as busy as they can be, there is nothing new to report.

NOTES FROM THE SOUTH-WEST.

Carmarthenshire Mineral Railway.—This proposed line, if carried out, will commence by a junction with the Carmarthen and Cardigan Railway, at Carmarthen; and passing through the important lime district of Llangendeirne and Porthyryd, and the rich mineral country of the Great Mountain, it will terminate at Pontardulais, joining the Llanelly Railway at that place, in direct communication with the port of Swansea.

The Nine Hours' Movement at Bristol.—There are rumours of an intention, on the part of the skilled mechanics of Bristol, to strike for the nine hours' system, after the example of their Newcastle comrades. The Bristol men are said to be awaiting the receipt by their employers of some considerable foreign orders which are anticipated. On these orders coming to hand, the men are said to look forward with confidence to the enforcement of their views and demands.

A River across the Taff.—At a meeting of the Cardiff Local Board of Health, on Friday, the surveyor reported that the Bute Trustees had consented to a weir being thrown across the Taff, near the South Wales Railway, or rather the South Wales division of the Great Western Railway bridge, on the other side of which a sewer could be carried to enable the new district to the west of the Taff to be drained into the Cardiff sewers. By means of the weir the whole of the new district can be drained into the old sewers at one-third of the expense of a proposed scheme to make a syphon under the river with pumps on each side.

Messrs. Waring at Bristol.—It is stated that Messrs. Waring Brothers have offered to widen Bristol Bridge at a cost of 5000*l.*, on condition that the citizens consent to their laying a tramway through the city.

State of Trade at Merthyr Tydfil.—The trade of the Merthyr Tydfil district continues unaltered. The men of the Aberdare and Rhondda valleys have been working steadily. At the iron works there has been a good steady trade doing, and further orders are anticipated. A good deal depends, however, upon the course taken by the labour question.

E. Finch and Co. (Limited).—The shareholders in this company, which carries on the Bridge Works, Chepstow, are about to receive a dividend at the rate of 5 per cent. per annum. Additional machinery is required to meet the increasing business of the company.

Midland Railway.—It is reported at Bath that the Midland Railway Company, on the strength of Parliament having sanctioned the construction of the Bath and Evercreech line, will run some large and powerful steamers from Poole to Cherbourg. By this means it is expected that a journey from Birmingham to Paris could be effected in 11 or 12 hours.

State of Trade at Newport.—As the shipping season for several of the foreign markets is approaching its close the ironmasters are pushing forward their operations as rapidly as possible. American orders are still numerous, and there is a fair continental demand. There is a considerable current of business with the colonies, and especially with Canada. The steam coal proprietors are not quite so much pressed with orders as they were recently.

Labour and Capital in South Wales.—The labour market is still in a very unsettled state in South Wales. A conference of delegates of the Glamorganshire and Monmouthshire miners, colliers, and iron workers has demanded an advance of 10 per cent. in wages, or rather the restoration of 10 per cent., which, they state, was taken off in February, 1865, "when the money market was high."

Rhymney Railway.—The new junction line between the Rhymney terminus at the Rhymney Iron Works and the station at Nantybwch, on the London and North-Western Railway, was opened for passenger traffic on Monday. The communication thus formed opens up a direct route between Cardiff, Manchester, Liverpool, Glasgow, Edinburgh, and the north generally.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

Glasgow Pig-Iron Market.—Within a period of five weeks, commencing about the 23rd of August, the price of warrants in the Glasgow pig-iron market fell not less than 4s. 3d. per ton, the lowest price attained being 59s. 3d. per ton, which was reached on the 25th ult. Apparently the "bears" have had their day, the "bulls" seem to have come upon the scene for a time; at all events the prices have advanced, and the market has become somewhat firmer. A week ago 59s. 4d. cash and 59s. 7d. one month were the prices paid; yesterday, however, prices had improved to such an extent that 62s. cash was paid at the opening of the market, and even at the close 61s. 9d. cash and 62s. one month were obtained. To-day's market has been quiet—61s. 9d. one month and 61s. 7d. cash, closing nominally at the latter price. The shipments of Scotch pig iron last week were very good, being: Foreign, 15,185 tons; coastwise, 5707 tons; total, 20,862 tons. Same week last year, 14,383 tons. Increase as compared with last year, 6479 tons. The total shipments for 1871 are 624,620 tons; for 1870, 474,872 tons, showing an increase of shipments for this year as compared with last of 149,748 tons. The imports of Middlesbrough iron into Grangemouth for last week were 1830 tons; same week last year, 940 tons; increase, 890 tons. Total imports for 1871, 62,084 tons; till same date last year, 50,984 tons; total increase for 1871, 11,100 tons. The stocks of pig iron in the public stores have been reduced by well nigh 30,000 tons during the last few weeks. In Messrs. Connal and Co.'s stores there were 374,197 tons in stock, warrants for 367,250 tons at the end of last month; and in the Canal Co.'s stores 15,143 tons, with warrants 14,450 tons. The quantity of iron held by makers is almost entirely exhausted, in fact, some of the largest firms have orders on hand which they will not be able to complete for some time to come. The effect caused by throwing about 70,000 tons of Carron iron on the market is now nearly got over, and there is a pretty good demand for ordinary No. 3, although there is still a large quantity of English iron being sent to the founders. The number of furnaces in blast in Scotland at this date is 129.

New Malleable Iron and Steel Works.—It is stated that the new company, which I spoke of formerly as being formed chiefly among the Tharsis Sulphur and Copper Company's shareholders, for making rails under the Siemens-Martin patents, have now actually concluded arrangements with the representatives of the Duke of Hamilton for the acquisition, at Cambuslang, of 100 acres of land on which to erect their works. It is understood that the company will consist of twenty shareholders, each holding one share of 5000*l.*

The Clyde Shipwrights' Strike.—The Glasgow, Partick, and Govan shipwrights have now nearly completed the sixth week of their strike for an advance of 3s. per week. It will be remembered that the employers, with the exception of Messrs. Tod and McGregor (who granted the whole advance), met the workmen half-way in their demand, and offered an increase of 1s. 6d. per week. This offer was accepted at Greenock and Port-Glasgow, but was rejected in the yards farther up the Clyde, where the strike was continued with even greater vigour than before, and to-day the movement may be said to have reached a crisis. Last week notices were posted up in the building-yards threatening a general lock-out on the Clyde unless the men in the Glasgow district commenced work on Monday last on the same terms as their fellow-workmen in Greenock, &c. These notices have only had the effect of strengthening those on strike in the determination to carry their point; none of them resumed work on Monday, and at a crowded meeting held in the Princess's Rooms, Partick, on the previous Saturday, it was moved that if the increase asked was not conceded within a week, 6*d.* per hour should then be demanded. The motion, however, was not carried, it being resolved simply to adhere to the original request. In this resolution the Glasgow men are stated to have both the sympathy and the pecuniary aid of those in Greenock and Port-Glasgow. The men at Renfrew never came out on strike, the vast majority of them being engaged on contract work. Of late two or three meetings of employers and workmen have taken place, with the view of effecting a compromise; but, as both parties remained firm, no arrangement was come to, and in the meantime as many of the carpenters as can get work elsewhere are leaving Glasgow. Forty-one left for Newcastle on Saturday, fifteen left on the previous Wednesday, and there is said to be employment for about eighty more. The wages there are 20*s.* per week for new work, with extra for old work. Other twenty men were to leave this morning for Troon, and the total number remaining in Glasgow is only 170. Messrs. Tod and McGregor, who employ about 70 men at new work, and 140 at repairs, do not intend to join the other employers in the threatened lock-out to-day. The Port-Glasgow employers are personally opposed to the proposed lock-out, but the Glasgow Shipbuilders' and Engineers' Association have firmly resolved on the course they intend to pursue. The dispute is largely interfering with the completion of many vessels now in hand on the Clyde.

Clyde Wages and Thames Wages Contrasted.—A short leader note has appeared in one of the Glasgow daily papers this week, which has excited a great amount of consternation among employers and employed in the shipbuilding, engine building and boilermaking trades. It is based upon the reports of the Government inspectors who recently made the state of the metal manufactures of the country the subject of careful inquiry. In two columns there are given the rates of wages paid on the Clyde and Thames respectively, to blacksmiths, angle-iron smiths, rivetters, caulkers, platers and fitters, carpenters, and boatbuilders, joiners, blockmakers, painters, pattern-makers, fitters, iron-turners, &c. As given by the Government inspectors, the wages given in the same branches of labour show a marked contrast. The statistics were compiled some months ago, and, therefore, the contrast cannot be so marked now as the wages on the Clyde have been tending upwards in the interim while the wages on the Thames have practically remained unchanged. But taking the statistics as they are given, however, it may be stated as a general fact, that skilled labour in the above-named trades is paid on the Clyde at from 6*s.* to 10*s.* and even 13*s.* lower per week than on the Thames. For instance, blacksmiths are paid in Clyde engine shops, on the average, 27*s.* per week, and on the Thames 36*s.*; fitters 24*s.* 3*d.* as against 34*s.*; iron-turners, 25*s.* as against 36*s.*; pattern-makers 26*s.* to 27*s.* as against 36*s.*; and so on.

New Forty-Ton Crane for Glasgow Harbour.—The Clyde Trustees have approved of a recommendation from the Committee of Management to erect a forty-ton crane on the General Terminus Quay, at the east end of Meviebank shed. The trade of the harbour has of late increased with such enormous rapidity, that the crane accommodation is very insufficient, especially when the wants of the marine engine firms are considered.

The Sewing Machine Trade.—A few days ago there were no fewer than 291 cases of sewing machines from New York landed at Glasgow; and about the same time 575*l.* worth of sewing machines were shipped to Antwerp by the steamer Peru.

Wick Harbour Works.—Hitherto the autumn storms have had no effect upon the new harbour works at Wick. Since operations were resumed this year, the breakwater has been carried out to a further distance of 160 ft. Little more will now be done till next spring.

WIDE PLATES.—The widest plates hitherto made in Yorkshire were rolled on the 2nd instant at the works of the Farnley Iron Company, near Leeds, in one of their mills without reversing motion. One of these plates, which is sheared square, measures 8 ft. 2 in. each way, and is only ¼ in. thick, is on view at the company's warehouse, Bank-street, Leeds, together with a large semicircular front plate for a marine boiler, 12 ft. 6 in. diameter, with a flange round the outer circumference 6½ in. deep, and three holes for flues about 3 ft. diameter, cut and flanged 4 in. deep by special machinery.

THE COAL SUPPLY OF OUR NAVY.—The correspondent of the *Times* who has been with the combined squadrons during the recent cruise, writes as follows concerning the coal supply. He says: "Turning now to the question of the coal supply to the navy, in continuation of some previous remarks of mine relative to the very inadequate existing means of supply at Queenstown, I will here add a few words relative to the cost and quality of the coal supplied to Her Majesty's ships at Lisbon, as another step towards ventilating the whole question. Coals are supplied to Her Majesty's ships at Lisbon under contract, the price paid by the Admiralty being 24*s.* per ton, and the contract specially declaring that the coal must be one half Welsh and the other half north country. The contractor is bound to keep 1500 tons in store, which the Admiralty can purchase or not, as they please. The first striking fact to be learnt about this coal is that the Royal Mail and other steamship companies, whose vessels visit the port, will not take this coal at any price, owing to its inferior steam-generating properties as compared with bulk. The second fact is that the difference in the freight of coal to Lisbon between Sunderland and Cardiff equalises the cost on delivery in the Tagus. The third fact, as a deduction from the last, is that the Admiralty in paying the bill for the 3000 tons of this mixed coal supplied to the combined squadrons on their arrival in the Tagus from Queenstown the other day, will, in the inferior quality of the coal supplied as compared with Welsh coal, throw away 20 per cent. upon the total amount of the bill. I know nothing of Parliamentary or other pressure, which may be suspected of being brought to bear upon the Admiralty, and leading to such a state of things. I only know of the facts as I have stated them, and only remark upon them that the necessary remedial measures may be taken if it is considered in official quarters quite expedient to do so."

GUINOTTE'S EXPANSION GEAR.

We annex the two diagrams (Figs. 1 and 11) which we were compelled to omit from our description of M. Guinotte's Expansion Gear on page 201 of our last number.

RECENT PATENTS.

The following specifications of completed patents are all dated within the year 1870; and that year should be given in ordering them, at the annexed prices, from the Great Seal Patent Office, Chancery-lane.

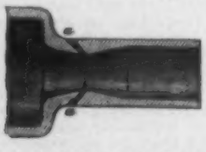
(No. 2812, 10d.) William Edward Gedge, of 11, Wellington-street, Strand, patents, as the agent of Hyacinthe Vigour, of Charleville, France, arrangements for facilitating the rolling of iron bars of square and circular section at alternate portions of their length. These arrangements consist in the application to ordinary rolling mills of a channel or guide for receiving the bars from the roughing and delivering them to the finishing rolls, the delivery being intended to be effected so as to insure coincidence between the round and square portion of the bar and corresponding parts of the channel in the finishing roll.

(No. 2816, 6d.) Frederick Burney, of Faversham, patents methods of manufacturing "pebble" gunpowder which we cannot describe in detail here.

(No. 2818, 10d.) James Stead Crosland, of Manchester, patents forms of steam boilers consisting of two barrels placed one above the other, and connected by rows of conical tubes, which are sometimes fitted with internal partition tubes. In some cases the lower barrel of these boilers is of very small diameter, being in fact merely a large pipe through which the boiler can be blown off and the feed admitted.

(No. 2819, 8d.) John Westray, of Barrow-in-Furness, patents apparatus for moulding cast-iron ingot moulds and similar castings. This apparatus consists of a moulding-box made in pieces, and properly fitted with a cover and base-plate, the latter being also fitted with a perforated hollow cast-iron core bar. In using the apparatus the core bar, surrounded by hay-bands, is placed in position on the base-plate, and the pattern being placed round it, the space between it and the pattern is rammed with sand in the usual way. The pattern is then removed, and the sides and top of the moulding-box are coated internally with an uniform layer of loam, and then arranged in position on the base-plate, and secured together. This method of preparing a mould for ingot moulds appears a handy one.

(No. 2820, 6d.) Edward Thomas Hughes, of 123, Chancery-lane, patents, as the agent of Jan Anthony Muller, of Amsterdam, forms of nozzles for fire engines, &c. The peculiarity of these nozzles consists in provision being made for the admission of air through oblique lateral or other



passages, close to the point at which the maximum contraction of the nozzle takes place. It is claimed that by the admission of the air at this point the delivery of the water is greatly facilitated. The annexed sketch shows one form of jet proposed, the openings for the admission of air being at *a a*.

(No. 2829, 1s. 4d.) William Robert Lake, of Southampton-buildings, patents, as the agent of Richard Vose, of New York, various forms of helical steel springs, some with, and some without india-rubber cores. Some of the bars used in making these springs are of peculiar fluted sections.

(No. 2840, 10d.) Richard Pudsey Dawson, of Delbury Hall, patents an arrangement of slide rest for enabling geometrical and ornamental patterns to be produced in the lathe. We could not describe this rest briefly.

(No. 2831, 6d.) Jacob Geoghegan Willans, of 9, St. Stephen's-crescent, Paddington, patents using as fuel peat, sawdust, or other ligneous matter, which had been roasted or "torrefied" at a temperature between 212° and a red heat, so as to dry it, and bring it into an easily friable condition; such fuel being carried into the combustion chamber by means of air. This patent also includes the combination of tar and lime with peat or other ligneous substances, to form sheets or slabs, and the manufacture of an artificial wood, suitable for firelights, &c., by combining pitchy or resinous substances with the "torrefied" ligneous matter already mentioned. Mr. Willans also claims a method of reducing pitchy substances to a fine state of division by agitation with non-solvents whilst both are in the fluid state, and then cooling the mixture, so as to solidify the pitchy substances.

(No. 2836, 1s. 4d.) Edward Field, of Chandos-chambers, Adelphi, and Richard Moses Merryweather, of Long-acre, patent improvements in fire engines. These improvements include a method of forcing air into the air vessels of a pump while the latter is in action—a plan which we intend to illustrate shortly—and also arrangements of pumping engines constructed on the principle of the oelipile, such engines being arranged to drive centrifugal pumps direct. A mode of creating a vacuum in the suction pipes of steam fire engines by condensing steam within the air vessels of the pumps is also included in the patent.

(No. 2845, 10d.) Richard Herring, of St. Mary's-road, Canonbury, and Robert Alexander Novare, of Twickenham, patent arrangements of telegraphic printing apparatus, of which we cannot give a description here, but of which we may have something to say on a future occasion.

(No. 2849, 8s. 8d.) John Cope Haddan, of 41, Trehorne-road, Brixton, patents arrangements of carriages for street tramways, and modes of constructing the permanent way of such tramways. A description of these plans would occupy more space than we could give to them here; but we may mention that Mr. Haddan advocates the adoption of a system of narrow tramway vehicles of such size as to be capable of being drawn by one horse. The details of the plans appear to have been carefully worked out.

PAGE'S TRAMWAYS.

The annexed engravings illustrate a system of tramway construction designed and lately patented by Mr. John Page, C.E., of Glasgow. It consists of a continuous cast-iron sleeper, made in lengths of 9 ft. On the top and about the centre a longitudinal slot is cast, and in this slot or groove a L-rail turned thus Γ is secured with wedges at intervals. The rails are of rolled iron in lengths of 18 ft., and, embracing three sleepers, are jointed at 4 ft. 6 in. from the end or joint of the sleeper, the most important part of the track being thus well secured and protected from injury. The mode of fastening the rails admits of their being easily removed without disturbing the roadway, so that when the continuous sleepers are well laid in concrete, Mr. Page expects that they will not require attention for years. Fig. 1, in our engraving represents Mr. Page's sleeper in transverse section, Fig. 2 being a part longitudinal section and part elevation, whilst Fig. 3 is a plan view.

The method of laying this tramway as proposed by Mr. Page is illustrated in Fig. 1, which is drawn to a larger scale than the other figures. He forms the bed of paving with concrete or asphalte as is usual in Glasgow, leaving a space between the paving stones. During the time the paving stones are being laid blocks of timber are placed in the opening to guide the paviors in their work. When a few lengths are thus formed the wood is removed and the space from A to B is filled up with concrete. The iron block is then turned downside up and filled also with concrete, and then put in position, with of course the rail side uppermost. Sand or grouting is then rammed between the paving stones and the blocks.

The cast-iron sleepers weigh about 66 lb. to the yard and the rail about 17 lb. to the yard. With this system so laid Mr. Page considers that it will hardly be necessary to tie the sleepers in the gauge, being well kept without the aid of tie-bars. Should they, however, be required, they can be easily passed through the casting and held in place by the bottom edge of the rail and its key, which will thus lock it. We are ourselves inclined to believe that the tie-bars would be found to be necessary.

As this system is said to effect in the first cost a saving of from 150*l.* to 200*l.* a mile, and a corresponding saving in maintenance, it is worthy of some consideration; but it is only fair to state, that although the system has been very favourably received in many quarters a fear has been expressed that it will be too rigid. In the case of a tramway, however, intended to be traversed at a moderate speed by properly constructed vehicles, we do not think that this objection possesses much force. We understand that Messrs.

FIG.1.

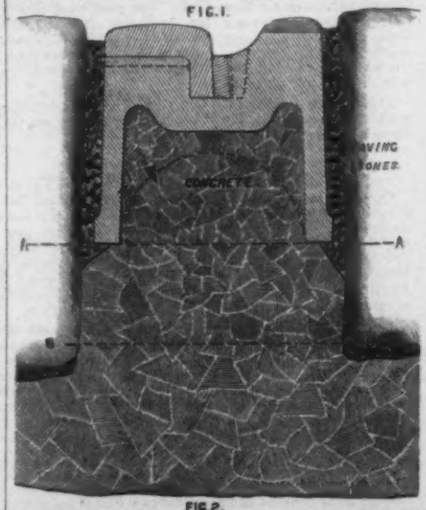


FIG.2.

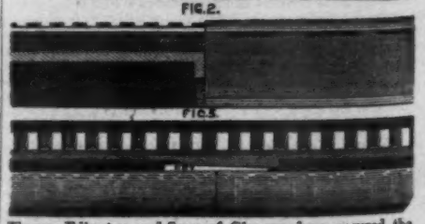
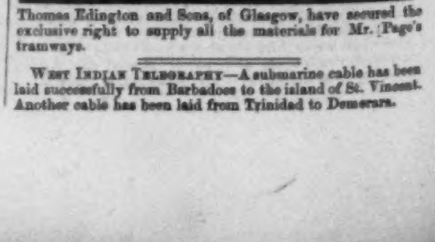


FIG.3.

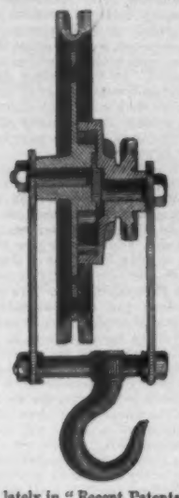


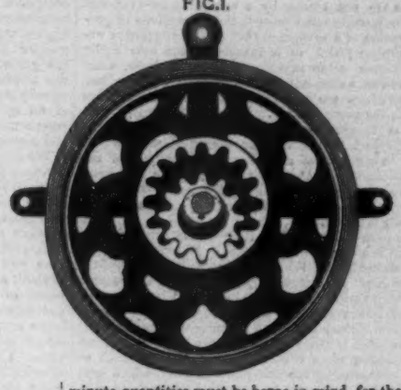
Thomas Edington and Sons, of Glasgow, have secured the exclusive right to supply all the materials for Mr. Page's tramways.

West Indian Telegraphy.—A submarine cable has been laid successfully from Barbadoes to the island of St. Vincent. Another cable has been laid from Trinidad to Demerara.

MOORE AND HEAD'S HOISTING PULLEY.

FIG. 1.





We noticed lately in "Recent Patents" a simple form of hoisting pulley designed and patented by Mr. Thomas Moore and Mr. Charles Arthur Head (of the firm of Head, Wrightson, and Co.), of Stockton-on-Tees, and we now give an engraving showing its construction. The arrangement consists simply of a pulley, over which a hand chain passes, cast in one piece with a pinion, and mounted on an axis, which is so cranked that on another part of it there can be mounted the smaller wheel or pulley, over which is passed the hoisting chain. This latter pulley is cast in one piece with an internal spur-wheel, into which the pinion already mentioned gears, as shown in the figures. The whole forms a very simple combination which will be useful in many cases.

SELENITIC MORTAR.

To the Editor of Engineering.

Sir,—In reply to the letter of your correspondent "C. E." with reference to the patent selenitic mortar, will you kindly allow me to make a few remarks upon the nature of this material and upon the chemical points involved in its preparation? Some years ago General Scott discovered, in the course of his examination of limes and cements, a fact entirely new to chemists; namely, that a very small quantity (about 2 or 3 per cent.) of sulphuric acid, if intimately mixed with quicklime (calcic oxide), had a very singular effect in modifying the behaviour of the latter with water. For whereas ordinarily the affinity of quicklime for water, to the formation of calcic hydrate, accompanied by the phenomenon known as slaking, is one of the most violent we know of; the presence of this small quantity of acid, when properly mixed, entirely deadens this action and the combination with water is so far retarded, that, in lieu of heating and passing into a bulky powder, the lime is then converted only very gradually into the hydrate and solidifies its water after the mortar so made has been applied in the work. Now the first result of this process is a much denser mortar and one which will carry with advantage a vastly increased quantity of sand, and in the cementitious qualities thus obtained lies the chief value of the new material.

If bearing these chemical facts in view we turn to the letter of "C. E.," we find that the lime employed for *his* selenitic mortar made many years ago was "thoroughly slaked," and, therefore, it was not selenitic mortar in our sense at all.

Then with reference to the mode of conveying the sulphuric acid to the quicklime—which according to the patent is done by using water as a carrier—the necessary amount of acid is obtained by adding to this water enough of oil of vitriol or of some soluble sulphate to equal in quantity say 2½ per cent. of acid of the lime used. In your valuable article quoted by "C. E." the accidental omission of the word "*or*" would seem to imply that one of the sources of sulphuric acid employed by us, "viz. green vitriol," was merely another form of calcic sulphate which, owing to its cheapness and universal distribution as plaster-of-paris, is perhaps the best source of the acid. For laboratory experiments the acid itself is the best thing to use, though in actual practice we recommend the employment of plaster.

These statements will, I think, dispose of the second of the objections of "C. E." The third point raised is the mixture of Portland cement with green vitriol, and here my experience is at variance with the observations of your correspondent. I have not found that good Portland cement is influenced by treatment with the small dose of acid we advocate, though the set of a light, limy Portland, is thereby retarded, and inferior Portlands being by this process deprived of their dangerous property of blowing, may be said to be improved. Our patent, however, in noway relates to Portland, which acts owing to the hydrated double silicates of lime and alumina, and can obviously not be hardened in the manner suggested by "C. E.," namely, by the introduction of substances tending to form calcic sulphates which are not only comparatively soft, but also very soluble.

This brings me finally to the consideration of the chemistry involved in the singular behaviour of caustic lime in the presence of very minute quantities of sulphuric acid, and these minute quantities must be borne in mind, for they prove the chief stumbling-block in the way of many would-be exponents of the nature of selenitic mortar. Some very good chemists have said, "Why you are only making calcic sulphate in a roundabout way;" forgetting that to convert 100 parts of calcic oxide into calcic sulphate, would take about 143 parts by weight of sulphuric acid instead of the three parts we use, and that we should then only get a very soft and rotten mortar quite incapable of carrying sand in lieu of a dense hard setting cement now resembling Portland.

How, then, does this acid operate? This is a question which is still undetermined by chemists, though a simple solution points to species of contact action, whereby the free acid combines with an atom of quicklime to form in the presence of water hydrated calcic sulphate, which immediately after this combination has taken place passed on its acid to the nearest particle of lime, leaving behind it an atom of calcic hydrate. This hydrate, owing to the intervention of the acid, has been formed in an entirely different way to the hydrate of ordinary mortar. As the lime is in the nascent state, this action might readily take place and a very small quantity of sulphuric acid well distributed would speedily pass through the mass. Such, at any rate, is the chemistry of selenitic mortar, as explained by General Scott, and I would ask those of your readers who are interested in limes or cements to give to this subject their careful consideration. The very surprising results which have been attained by this process are already exciting the attention of some of our most eminent architects and engineers, and point to an entire change in the mode of using lime for building purposes.

I am, Sir, your obedient Servant,

Gilbert R. Redgrave.

Lambeth, October 2, 1871.

The Lowe-Vansittart Screw Propeller.—We are informed that Mrs. Vansittart is rapidly extending the application of her special form of screw propeller to private steam ships as well as to Government vessels; of the latter class, so much satisfaction has been afforded by the vessels already fitted, that orders for several more have recently been issued. Of the former, out of the fleet of colliers belonging to the Victoria Docks Engine Works Company, some have been supplied with the propeller. Upon the vessels of other companies the varying curve lines which form the subject of the Vansittart propeller patent of 1868, have been adapted to the pear-shaped section of screw with which the name of Mr. Griffiths has been associated ever since 1853. We may add that a 1st class certificate was awarded to Mrs. Vansittart by the Italian Government for her exhibits at the Naples Exhibition.

The Last of the Collins Mail Steamers.—A curious sight was witnessed on the Mersey on Saturday last. At high water, about noon, there was towed out of the Birkenhead docks, already for sea, an enormous wooden full-rigged ship, with a straight stem, and that curious dumpy stern which is peculiar to some American shipbuilders. This was the once famous paddle-wheel mail steamer Adriatic, the last addition to the Collins line of steamers, established by an enterprising American firm to share the Liverpool and New York passenger trade with the Cunard Company. When the Collins line was given up, the Adriatic was run for some time on the station between Southampton and New York, and her magnificent fittings and high speed made her a favourite to passengers. Afterwards she was one of the fleet of the abortive Atlantic Mail Company that ran steamers between Galway and New York under the auspices of a government mail subsidy obtained through the influence of Mr. J. Orrell Lever and Mr. Roebuck. When that scheme failed, too, the Adriatic was laid up in Birkenhead docks, close to her old rival the dismantled Persia, of the Cunard line. Recently she was bought by the well-known ship-owning firm of Edward Bates and Son, of Liverpool. They took out her machinery, and rigged her as a ship, and on Saturday she sailed from the Mersey for Rio Janeiro, with 3800 tons of coal on board, her registered tonnage being 3300. As she was towed down the Mersey at full tide her enormous size and "ship-shape" appearance excited universal admiration, and it seemed something like extravagance to degrade such a splendid-looking vessel into a coal hulk—which is, we believe, her ultimate destiny, her vast size enabling her to carry about 6000 tons.—*Standard.*

RANDOM NOTES FROM NORTHERN INDIA.

N.W. Provinces, July, 1871.

The monsoon has come on us this year with unusual violence, enormous floods are rolling down our rivers, the road engineer trembles for his bridges, and the canal officer sighs over his submerged dam, while the "oldest inhabitant" (they are not a numerous body in a moving community like ours) declares that nothing like it has ever been seen. One paper announces that Allahabad is in danger, as the spurs built by the luckless Public Works Department cannot resist the encroachments of the Jumna and Ganges. Another informs us that the Sutlej Bridge has been closed as a precautionary measure, and that the Cawnpore Bridge of boats has been quite carried away. Well indeed, may the engineer dread the approach of the Indian monsoon, for year after year it teaches him the sad lesson that in the struggle between art and nature the latter is often too strong for the former. The civil engineers of the Public Works Department, who have so long been hoping against hope, for an amelioration of their grievances, have lately received a very severe blow, and one under which they are bitterly smarting just now. A new warrant of precedence has just been issued, and while educational officers and others of the higher branches of the uncovenanted service (who were allowed no status before) have lately had a high standing allotted to them, the whole body of civil engineers, except those filling the very highest offices—chief and first grade superintending engineers, and they do not number half a dozen—have been omitted altogether, so that it must be inferred that a profession which has done more than any other for the advancement of civilisation in the world, and to which India owes much in the past, and from which she expects much in the future, is considered unworthy of any social status in our great Indian Empire. This has been a heavy blow to the hopes of many who looked forward to an early change for the better, for they naturally argue that when they have been refused a concession which would cost nothing, their chances of obtaining the others asked for, viz., improvement in leave and pension rules, are but small indeed, and there is a strong feeling abroad that this treatment badly accords with the professions of appreciation and expressions of consideration conveyed in Colonel Strachey's minute, which was published at the time the Institution of Civil Engineers made their famous protest against the "obnoxious notification."

Young men coming to India do not much feel the ban under which their profession is placed, but when weary of a solitary life in Indian jungles they take unto themselves a partner for life, lucky are they, indeed, if they are not often made to feel (bitterly and keenly through their companion) the meaning of the term "uncovenanted servant," as interpreted by the most exclusive of all society, an Indian official community. This has been termed a mere sentimental grievance, but life in India has quite sufficient to depress and enervate the most buoyant without the addition of cold treatment and indifference from one's own countrymen. Young engineers, with all that happy hopefulness peculiar to youth, predict an early adjustment of all the grievances of which the engineers complain, but the older ones who know how deeply prejudices are rooted in this soil, shake their heads and foretell that many a year must pass before the civil engineer will in every way be placed on terms of equality with his military brother.

A paper is now being circulated amongst the civil engineers of the P. W. D., showing a comparison between the leave and pension rules under which they serve, and these applied to the military who are employed in the same department, and engaged on exactly similar duties, and very well and clearly does it expose the gross anomalies which are allowed to exist, and go on year after year, causing baneful heartburnings and bitter animosities, who is to blame for allowing this state of things to exist, it is difficult to say, but it may be right to mention that the impression prevails here that the Government of India would have long since listened to the complaints of their civil engineers had they the power, but that the Council of India (a body of old civilians who know not the India of to-day, or her wants) stands in the way. Whoever may be responsible for it the mischief done is great, for that there is a strong feeling of discontent and dissatisfaction, and worse than all a want of faith in the good intentions of the Government, growing up amongst a most useful and numerous body of public servants, is a sad fact to which it is impossible to close one's eyes. Let us hope that better counsel will prevail, and that the sense of justice and fair play may, before long, predominate over unfair and antiquated prejudices.

The report of the consulting engineer of the Oude and Rohilkund Railway up to 30th March, has just been issued and it shows satisfactory progress, so much so that there appears to be every prospect of the completion of these valuable lines by the beginning of 1873. Some of the papers in commenting on this report have called attention to the work which is being done on this line as compared with the progress made on the state railways, which latter appears to be considered on all sides very unpromising. It is to be hoped that the great falling off in the receipts of some of the Indian railways will not act as a damper on, and further retard the progress of the proposed state lines, which already exist almost altogether on paper only. The experiment of putting a small steamer on the Ganges

canal is about to be tried; and if successful, it will most likely be followed by others. The current in this great canal is so strong as almost to prohibit ordinary boat navigation, and it now remains to be seen whether steam will overcome this difficulty. When will common sense teach our engineers that the union of navigation with irrigation is destructive to the interests of both?

ON THE USE OF PULVERISED FUEL.

By Lieutenant C. E. Dutton, U.S. Ordnance Corps.

(*Continued from page* 198.)

2. For the complete combustion of a fuel of a given constitution, a fixed proportion of air is necessary. When the combustion is complete, we have obtained certain gases, having a definite volume, an average specific heat, and a fixed temperature, which is the maximum temperature which that fuel is capable of imparting. This assumes, of course, that no adventitious heat is added. If an excess of air be supplied, then that excess represents a useless volume, through which the total heat must be distributed, with a consequent lowering of the temperature. If air be deficient, then the fuel will be imperfectly burned, becoming carbonic oxide instead of carbonic acid, and yielding much less heat, with about the same volume of gas, and a consequent lower temperature. We approach the maximum temperature in proportion as we approach the exact proportions of air and fuel necessary for perfect combustion. In common grate burning we depart widely from exactitude in these proportions. At one period we have a grate heaped with fresh fuel, giving off half burned, or wholly unburned, gases; at another, half exhausted coals, coated with ash, to which only a portion of the oxygen can obtain access. The draught, on the other hand, is constant, or only occasionally varied. A stream of air, driven through a bed of ignited coals, first oxidises the lower layers, converting the carbon it touches into carbonic acid. The latter gas, rising through the bed, takes up more carbon, becoming carbonic oxide, which is, in part, re-oxidised again just above the coals, giving rise to flames. Unless there is a large excess of oxygen, there is a probability that some of the combustible elements of the gases will be unconsumed, owing to imperfect intermixture, and a rapid cooling below the point necessary to insure ignition by the nearly exhausted oxygen. If hydrogen be present in the form of hydrocarbon vapours, it will, by its stronger affinity, appropriate oxygen, to the exclusion of carbon, and even decompose carbon already oxidised, the latter element passing off in minute flakes, which constitute the dense black smoke always abundantly developed where bituminous or hydrocarbon fuels are burned in an insufficient supply of air. In the puddling furnace these circumstances are more or less modified by admitting a draught over the grate, but the loss of fuel is by no means wholly obviated by this means. In practice, it is usual to drive through the grate at least twice the quantity of air theoretically necessary to oxidise the entire mass of fuel. Indeed, two to one is oftener exceeded than fallen short of. The effect upon the temperature is corresponding, as will appear from the following simple estimates. If a pound of bituminous coal were perfectly burned in a volume of air just sufficient to oxidise all of the combustible elements, the result would be as follows: After deducting the latent heat of vaporisation, there would be developed about 13,000 units of heat. The resulting gases would occupy (if their temperature were reduced to 60°) 146.6 cubic feet, with an average specific heat of .26. Their temperature would therefore be $T=\frac{13,000}{11.22\times.26}+60°$ $=4516°$; provided no heat were lost by radiation. If twice the volume of air were used, then $T=\frac{13,000}{22.44\times.24}+60°=2474°$, or a little more than half the temperature under the first supposition. Assuming the air to be 50 per cent. in excess, then $T=\frac{13,000}{16.83\times.25}+60=3150°$.

Now, it needs but to state the conditions under which pulverised fuel is supplied to the furnace to make it very clear that those conditions are extremely favourable to combustion with a greatly reduced supply of air. We have shown good reason why the enormous excess of 100 per cent. is generally necessary in grate burning. But with pulverised fuel the conditions are radically changed. There, every particle of fuel enters the furnace surrounded by, and in contact with, the very oxgen that is to burn it. The fuel and the air are as perfectly intermixed as possible by the powerful agitation of the pulverising machine, and at the moment of ignition the former exposes an enormous surface to the action of the latter. The combustion should therefore be rapid, and very nearly complete, and this without the liability to distil a large portion of gases, or to appropriate carbon from other parts of the fuel less exposed to oxidising action. Perfect intermixture is essential to perfect combustion. When a current of gas and one of air are brought together, it requires time to mingle them perfectly, and if they are ignited at the junction of the jets, some of the gases will escape combination, though the proportions of each may be exact; for the two are carried forward in eddying currents and whirls, which cannot intermingle until some time after they have cooled down below the temperature of ignition. Hence we have carbonic oxide, free carbon, oxygen, all escaping from flues and stacks without undergoing combination, and representing so much lost fuel, and adding to the superfluous volume of gases besides. But with pulverised fuel the essential condition of intermixture is vastly improved, so that we seem to approach that perfect intermixture obtained by the transfusion of gases, where atom is in juxtaposition to atom, and we are removed from it only sufficiently to avoid the explosive action attending the contact of flame with perfectly mingled gases. More strictly, the condition of pulverised fuel, sustained in air sufficient to burn it, may be represented by a cube of air $\frac{1}{10}$th of an inch on its edge, holding in its centre a particle of coal.

Now, it is not maintained that these conditions are in their nature such as to insure the perfect combustion of the coal with the theoretical minimum of air, for it is possible to detect circumstances which may, in greater or less degree, interfere with such a result. It must be borne in mind that these particles are not atomic by a very wide interval, and hence their combustion must present the phenomena of progressive absorption of a surface of fuel, and a progressive exhaustion of oxygen; and, as is invariably the case under these circumstances, some minute portions, at least, must escape combustion, unless oxygen be in excess. Then, too, some of the particles are of material size, rendering these phenomena all the more decided. But, on the whole, it certainly seems as though the conditions in question were such that coal, pulverised in the manner described, may be perfectly burned in a supply of air not greatly in excess of the theoretical minimum. At any rate, they are far more favourable in this respect than the best possible method of grate burning, and probably better than any practical existing method of gas burning.

A prolific source of loss exists in the ordinary reverberatory furnace, which is obviated in great part by Messrs. Whelpley and Storer's method, viz.: the loss by radiation from the fire-place. Of the heat generated, only that portion exerts any useful effect which is carried into the hearth. A very sensible amount is lost, however, before the flames enter the hearth. This amount is variously estimated by different investigators, none of whom place it lower than 5 or 6 per cent. This need not seem surprising when it is remembered that the area of the surfaces surrounding the fire-place through which heat may be totally lost, amounts to one-third, at least, of that of the hearth itself. Also, at a very high temperature heat is radiated and conducted away with a rapidity much greater than that due to a simple ratio of the interior to the exterior temperature. This loss is doubly serious, from the fact that the temperature of the flame, at its hottest point, is inconveniently near to that required in the bath of metal itself. The pulverised fuel furnace, on the other hand, does away almost entirely with the fire-place, and burns its fuel with nearly explosive rapidity, in the hearth itself, avoiding this loss almost completely.

These results may seem surprising to practical men, and yet they may rest assured that they are in perfect conformity with well-established facts and principles in physical science. It is not proposed to obtain any more heat out of the combustion of a quantity of coal, but merely an increased temperature from the same quantity by diminishing the volume of gas through which that heat is distributed. We also burn the fuel more completely, and lose less heat by radiation. With this increased temperature we increase the efficiency and rapidity of all operations requiring the acquisition of temperature, and thus shorten the time during which we are compelled to burn the fuel. Let us therefore apply this deduction of increased temperature to the practical management of the reverberatory furnace.

The economy of high temperatures over low ones (provided they are obtained without enormous increase in the consumption of fuel, and provided, also, they are not so great as to act destructively upon the materials subjected to them), is vastly greater than would at first seem, and out of all proportion to the increase. It is an unfortunate fact, that the temperatures at which the operations of heating and puddling are performed, approach near to the extreme temperature attainable in the flame from the grate. After the fire has been in operation a few hours, the temperature of the roof, walls, and bath of metal, will be equal to that of the flame, less the temperature lost by conduction through the walls. At high temperatures this loss is known to be very great, and is proportional to the time occupied by the gases in passing from the fire-place to the throat. If the flame have the maximum temperature due to that mode of firing, then the only way in which it is possible to increase the temperature of the bath of metal is to increase the volume of gases passed through the furnace, and the consequent velocity with which they pass; we then diminish the time, diminish the proportional losses of heat and temperature—thus bringing the temperature of the bath nearer to that of the flame. But the proportional increase of temperature thus obtained is much below the proportional increase of fuel expended.* This is illustrated daily by unskilful, ignorant heaters, who send through the hearth immense volumes of flame and gas, under the impression, no doubt, that the effect produced is directly proportional to the quantity of fuel consumed, while, in reality, very little, and sometimes no increase of temperature is obtained. The efficiency of heat, or the rapidity with which its effects are communicated, are related in a complex ratio to the difference between the temperature of the radiant and that of the recipient. For a given difference it varies in an increasing ratio with the absolute temperature of the two elements.

Let us apply these considerations to the various stages of the puddling process. The first stage, where the iron is melted, may be materially shortened by the more intense heat of pulverised fuel. In the second, or boiling stage, time is required to perfect the chemical reactions, and its duration cannot be materially shortened by any amount of heat. Moreover, it is desirable to boil at the lowest temperature consistent with perfect fluidity. But the much greater temperature obtainable by the use of a given supply of coal, in the form of dust, enables us to reduce the rate of consumption very materially, and yet preserve a sufficient temperature. In the third, or balling stage, where the highest temperature is required, we may attain it by a much smaller increase of consumption than would be necessary by the grate-burning method. In the heating furnaces, also, the advantages of increased temperature of the flame are equally conspicuous, since they materially shorten the time of an operation, and obviate the necessity of increasing enormously the consumption of fuel, in order to obtain the last increments of heat in the pile.

We may observe here the operation of a general law of thermal physics, that the rapidity of thermal action due to given differences of temperature, is greater at high temperatures than at low ones, and hence when we add to our command of it we increase in two ways: we increase the number of our units and augment largely the value of each unit. Hence we account, by means of simple physical laws and familiar facts, for the greatly increased effects of small additions to high temperatures. We are also prepared to consider entirely just and reasonable the claim put forward by Messrs. Whelpley and Storer, of a very large economy obtained by their process, in the expenditure of fuel in the operations of the reverberatory furnace. They state that in a practice extending over eight months, the use of a pulveriser attached to a double puddling furnace has given a general average consumption of 1250 pounds of coal to the ton of puddle bar. It is usual to estimate ordinary puddling at a ton of coal to the ton of iron, in which case pulverised fuel would give an economy of 45 per cent. of the amount at present used. Large as this claim may seem, every theoretical and practical consideration with which I am familiar, leads me to the belief that it is entirely rational and intrinsically probable.

But Messrs. Whelpley and Storer have not only demonstrated in their experimental furnace at Boston, that a much higher temperature is attainable by the use of pulverised fuel than by the grate-burning method, and this with less coal; but they have also obtained, at moderate cost, a temperature comparable to that obtained in the Siemens furnace. This will not appear at all surprising when we come to examine the facts of the case. The temperature of the Siemens furnace is not by any means so high as is usually supposed by those who have never investigated it. By whatsoever method this investigation be conducted, it will readily appear that this temperature cannot be more than 350° to 400° Fahr. above that of the common reverberatory furnace used for heating, and is probably less even than that—say 2500° to 2550° Fahr. This applies, of course, to the ordinary temperature of that furnace when making steel, which may be melted at about 2500° Fahr. That the temperature cannot be more than slightly above this melting point is clear, from the great length of time required to attain complete fusion. M. Ch. Schinz has also shown, by an elaborate calculation of the amount of heat carried into the regenerators and returned to the gases, that this should be the approximate temperature, and has verified his calculations by long and careful experiments. When we compare gas burning with dust burning, we may readily find abundant reason to expect, that by the addition of hot blast we may easily obtain in the reverberatory furnace a temperature fully equal to the Siemens. Messrs. Whelpley and Storer heat the air blast by means of a stove quite similar in principle and general structure to that employed for blast furnaces, and located beyond the throat of their furnace, where it is heated by gases issuing from the hearth. Now, in the Siemens furnace the fuel is half burned, or more than half burned, in the generators, and the gases purposely cooled down in the great flue, in order to give them propulsion, and to condense the hydro-carbons, which would otherwise clog the regenerators. The heat so dispersed is a total loss, and it includes that derived from the perfect combustion of the greater part of the hydrogen, which has the highest thermal equivalent of any elementary substance; so that the entire heat of the hearth is derived from the combustion of nearly pure carbonic oxide, plus the heat received from the regenerators.* But pulverised fuel yields to the hearth the entire thermal equivalent of its compounds, which fact must go far towards compensating the effect of the regenerators; and we can easily compensate the remainder by heating the air blast, and this with the same expenditure of fuel as by the Siemens method. I see nothing in this application of hot blast which does not appear to be entirely practicable and simple.

I am able to certify that I have seen the foregoing results amply verified at the experimental furnace of Messrs. Whelpley and Storer, at Boston. There were charged upon the hearth 200 lb. of pig iron, which was melted in 17 minutes, to which were added successive charges of wrought iron scrap, amounting to 800 lb., and the whole was tapped off in 2 hours and 50 minutes from the time of charging the pig iron. The ingots contained only about $\frac{1}{10}$ per cent. of carbon. The consumption of fuel was 177 lb. per hour of bituminous coal and anthracite slack, mixed in the pulveriser, and 29 lb. of anthracite culm in the fire-place. The hot blast stove was a mere temporary and imperfect affair, at no time above a just perceptible red heat, and yielding a blast certainly not above 450°; whereas, it might be made to yield readily 800° to 900° at the tuyere. Indeed, the temperature at command by this method is limited only by the ability of the furnace materials to withstand fusion, and this temperature is attained by burning a much smaller quantity of fuel than is required in the old reverberatory heating furnace for obtaining a welding heat.

(To be continued.)

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* Let Q=the quantity of heat required to raise the temperature of the gases to 2500.° Say the temperature of the bath is 2200°, in which case 300° is lost by radiation, or Q.12. We desire to raise the temperature to 2300°, in which case the loss would be .08 Q′. This can be effected only by making Q′ much larger than Q. The proportion Q′ : Q : : .12 : .08 would be insufficient, because the rate of loss at 2300° is greater than at 2200° by about .06; making the proportions Q′ : Q : : .12×1.06 : .08, or $Q'=Q\frac{.12\times1.06}{.08}=Q\times1.59$. In other words, requiring 59 per cent. more heat. As the temperature of the gases is assumed to be the same in both cases, the increase must be in their volumes, which represents a corresponding increase in the quantity of fuel burning. [The temperatures selected are arbitrary, and for purposes of illustration only; still, the foregoing estimate approximates to the real facts of the case.]

* The heat developed by burning C O to C O^2, should be greater than by burning C to C O, because in the latter case much heat becomes latent by vaporisation, i. e. the conversion of a solid into a gas. The differences of specific heats are also in favour of the former.

ICE MANUFACTURE.

In our previous notice* of this indispensable article of commerce we referred to the method of obtaining supplies from natural sources. We now propose to direct attention to the artificial means of supplying the requirements of the public, to insure which the aid of machinery has been invoked. We have seen that the use of ice in this country is rapidly on the increase, but as long as we depend upon our uncertain home supply, and on the imports from Norway alone, the expense will prohibit that general use of ice so prevalent in America, and so much to be desired everywhere. Although the severest English winter might fill private ice-houses and the ice-wells of the dealers, it would not yield ice of reliable purity for table use and other similar purposes. In our previous notice we showed that the quantity of ice imported in 1869 was 110,000 tons, whilst to this may be added the home crop gathered from ponds, lakes, and rivers, the yield from which sources is estimated to be twice the quantity of that imported. The ice trade of this country is, therefore, between 300,000 and 400,000 tons per annum, at prices varying from 18s. to 50s. per ton, according to quality, the prices being also influenced by the lateness of the summer. This large demand for ice would undoubtedly be increased, could ice of a pure quality be produced in large quantities and at a cheap rate in this or any other country, where the home supply was small and uncertain. To this end, then, considerable attention has for some time past been given to freezing machines, by which ice could be produced and sold at prices which should bring it within the range of every one. That a cheap and efficient ice-producing machine would prove of commercial value there can be no question, and such an article—on a small scale—is still a desideratum. The use of ice as a source of cold is becoming more extended. In India it is often prescribed by medical men as a cooling medium, and in the temperate regions public health has been improved by its use. Further advantages would undoubtedly accrue if it were more largely employed than it is in the preservation of meat and other perishable articles of food. It is calculated that in London alone upwards of 2000 tons of meat are lost every summer from the effects of heat. In South Carolina but little loss arises from this cause, in consequence of the practice of keeping provisions in a public ice-house.

The principle of evaporation has been commonly applied in all ages to the cooling of liquids, the medium being vessels made of porous materials. The most ancient example, however, of the artificial production of ice is probably that carried on in the upper country near the town of Hooghly, about 40 miles from Calcutta. During their short winter, which ranges from the end of November to the middle of February, the natives are enabled to procure a supply of ice by a skilful application of the principle of evaporation. The process of manufacture is as follows: In a large open space of ground several troughs are formed, each being about 120 ft. long by 20 ft. wide and 2 ft. deep. The bottoms of the troughs are made smooth and dried by exposure to the sun, after which they are covered with bundles of rice straw to the depth of 1 ft. Upon this, loose straw is then strewed to a depth of 6 in. more. Upon the top of the straw beds are placed a series of unglazed porous earthenware pans similar to our garden flower-pot saucers. They are arranged in regular order, close to each other, to the number of 5000 or 6000. Near the pits where the ice is stored are large water-jars sunk deep into the ground, and they are supplied with water from the neighbouring pools and from the drainings of the ice. The ice-pans are fed with water from these jars, the quantity poured into each pan varying from one-eighth to half-a-pint according to the clearness of the sky and steadiness of the wind. The most favourable wind for ice making is from the N.N.W., but any point between N. and W. will answer, although a smaller quantity of ice is produced, whilst if the wind is between E. and S. no ice will be formed. The ice begins to appear a little before midnight, and as soon as a slight film of ice is formed the contents of several pans are mixed together and the freezing liquid sprinkled over others. By sunrise about an eighth of an inch of ice will generally be found in each pan, except on very favourable nights, when the whole contents are sometimes frozen. This, however, is a very rare occurrence. The ice is then removed by women who use a blunt semi-circular knife with which they scoop it out and throw it, together with any unfrozen water, into earthen vessels. When these vessels are full their contents are emptied into conical straining baskets placed over the large water-jars from which the pans are filled, a supply of cool water thus being collected for the following night's operations. The drained ice is next deposited in wells near the ice beds, and at night it is removed to large circular pits lined with mats and covered over with a straw shed. Notwithstanding all precautions a partial thawing generally goes on in the pits as the temperature in the daytime—even in the ice-making season—is frequently higher than on a hot summer's day in England. Holes are, therefore, formed in the bottoms of the pits through which the water is drained off to a deep well from which the ice pans are also supplied. Thus throughout the process the cold is economised as much as possible. The ice is conveyed in boats to Calcutta by night, being packed in bags when the weather is coldest, but on a rise of temperature it is packed in baskets lined with straw mats. This supply, however, is rarely available during the hot season when it is most required.

The production of cold is simply the manipulation of heat, and the various ice-making machines of modern times may be resolved into two general classes. These are, those in which heat is applied direct to produce cold, and those in which heat is used in the first instance to generate power which in its turn is applied to the production of cold. Those machines in which cold is produced by the action of power may be subdivided into three classes; first, those in which air is compressed and water evaporated by power. In these the heat is generated and then given out during compression, the compressed air being cooled and then allowed to expand, doing work at the same time, otherwise no cold would be generated. The second class of machines are those in which power is used to liquefy certain gases such as ammonia, methylene, &c. Here, on the removal of pressure the liquefied gases boil at very low temperature, and are reproduced as elastic fluids to be re-liquefied by means of power and used many times over. In the third class ether, bi-sulphide of carbon, acetone, &c., are made to boil considerably below their boiling point, under the reduced pressure effected by an air pump. The best machines are those using ether, inasmuch as the vapour of that liquid possesses a superior density to that of the others. It also possesses a greater capacity for the absorption of heat in a latent form, and boils at a lower temperature. These various principles have all been carried out in practice with a greater or less degree of success, as we shall now proceed to show.

The production of ice by the rapid evaporation of water aided by mechanical appliances, was tried more than twenty years since, but without commercial success. A machine in which an air pump was used to aid in evaporating the water, was driven by a 30-horse power engine, and the product was only from 10 lb. to 15 lb. of ice per hour. It is a fair calculation that to make 5 tons of ice per day upon this principle, more than an acre of evaporating surface would be required, whilst the amount of horse power to produce that result would be something fabulous. Passing by the various unsuccessful propositions and abortive schemes for the production of artificial ice, we will take up the history of the question in the year 1856, when Mr. Harrison, of Geelong, brought out an ice-producing machine in which the source of cold was derived from the evaporation of ether in a vacuum. The idea was not then new, the principle having been tried some thirty years previously by Mr. Perkins. In Mr. Harrison's apparatus, the parts are so arranged that the process is rendered continuous. The ether is placed in an air-tight metallic vessel, from which the air has been exhausted. The vapour from the ether passes into an air-tight metallic receiver, in which it is condensed under pressure. The condensed liquid is then transferred back to the first vessel, and this operation is repeated as often as necessary. The vapour is passed from one vessel to the other by means of an air pump, and the condenser is placed in water, which absorbs the heat given out by the ether. In making ice, the evaporator is also placed in water, so that the heat which is absorbed in the evaporation of the ether may be withdrawn from the surrounding liquid which is thus frozen. It is calculated that four tons of ice may be produced with the consumption of one ton of coal, which is necessary to generate steam for the engine to work the air pump.

In 1857 Mr. Harrison worked out the same principle in a modified and improved form. He evaporated the ether in the lower part of a tubular boiler, the vapour being carried by an air pump to the condenser. The heat is drawn from a current of saline fluid congealable only at the lowest degrees of temperature. After having been cooled in its passage through the tubes surrounded by the ether vapour and liquid, it is passed over the surfaces beneath which are the substances to be cooled. An ice-making machine on this principle about 18 ft. long and 11 ft. high, requires a 10 horse power engine to work it. The frigorific influence being spread over large surfaces in Harrison's machines, leads to economy in working; the great objection to them, however, is their costliness.

An improved form of machine working on a similar principle to Mr. Harrison's was shown in the International Exhibition of 1862 by Mr. Daniel Siebe. MM. Carré and Co. also exhibited a machine in which the cold is produced by the direct application of heat and the action of a solution of ammonia, which undergoes four changes. It is first evaporated and condensed; next the liquid is taken up by a distributor and supplied in regular quantities to the refrigerator, where it is again evaporated in order to supply the cold required. Thirdly, the vapour is carried along a pipe into the condenser, where it is absorbed by a weak fluid derived from the boiler. In the fourth place, the weak liquid having thus been strengthened by the absorption of the ammoniacal gas, is pumped back again into the boiler, partly in the form of vapour and partly in that of liquid. In a machine capable of producing 55 lb. of ice per hour, a vertical cylindrical boiler 4 ft. high, 1 ft. 4 in. in diameter, and capable of containing about 33 gallons, is employed. The efficiency of the apparatus depends upon the latent heat of the volatile fluid employed, and upon the quantity of vapour formed per hour. Carré's continuous or industrial apparatus is said to produce from 8 to 15 lb. of ice for every pound of coal consumed, whilst for every pound of ice formed a gallon of water is required.

It was at one time objected by some that the use of ether in refrigerating machines was both costly and dangerous, owing to its volatility and to the inflammability of its vapour. These objections—which only hold good as far as the earlier machines are concerned—led to the invention of an apparatus by Mr. Kirk, in which air is substituted for ether. The principle upon which the action of machines of this class depends is very simple. If air be pumped into a receiver under very high pressure it becomes exceedingly hot, according to the amount of pressure brought to bear upon it. If now the hot air be cooled by the application of water and then expanded, it becomes sufficiently cold to freeze water. In other words, the air re-absorbs from any object or substance with which it may be brought in contact the heat of which it has been deprived. The natural balance is thus restored, in effecting which the foreign substance becomes cooled or frozen. In Kirk's machine the air is compressed and cooled on one side of the piston of a large cylinder, and is expanded on the other. The heat generated in the compression part of the cylinder is carried off by water which surrounds it. The air passes from this compression chamber through a number of wire gauze screens into the expansion and of the cylinder where it is expanded to its original bulk, and in so doing it absorbs heat from the substance to be cooled. The expanded air is then passed back again through the wire gauze screens into the condensing chamber. The screens are used to prevent the heat flowing from the condensing end of the cylinder into the expansion portion; they are in fact heated by the air when on its way to the latter compartment. On its return, however, it takes up the heat from the gauze screens and passes into the condensing compartment in a warm state. This machine has been employed by Messrs. Young, of Bathgate, for cooling paraffine oil in order to extract the solid paraffine. Their experience of its working is that 1 ton of ice is produced with an expenditure of 1 ton of coal, the cost of which is there four shillings.

Wellington, Grey, and Bruce Railway.—Work on this line is rapidly progressing. Merchandise has been carried to Drayton, the grading is finished beyond Huston, and it is said that the road will soon be opened to Harristown.

* See page 179 of the present volume.